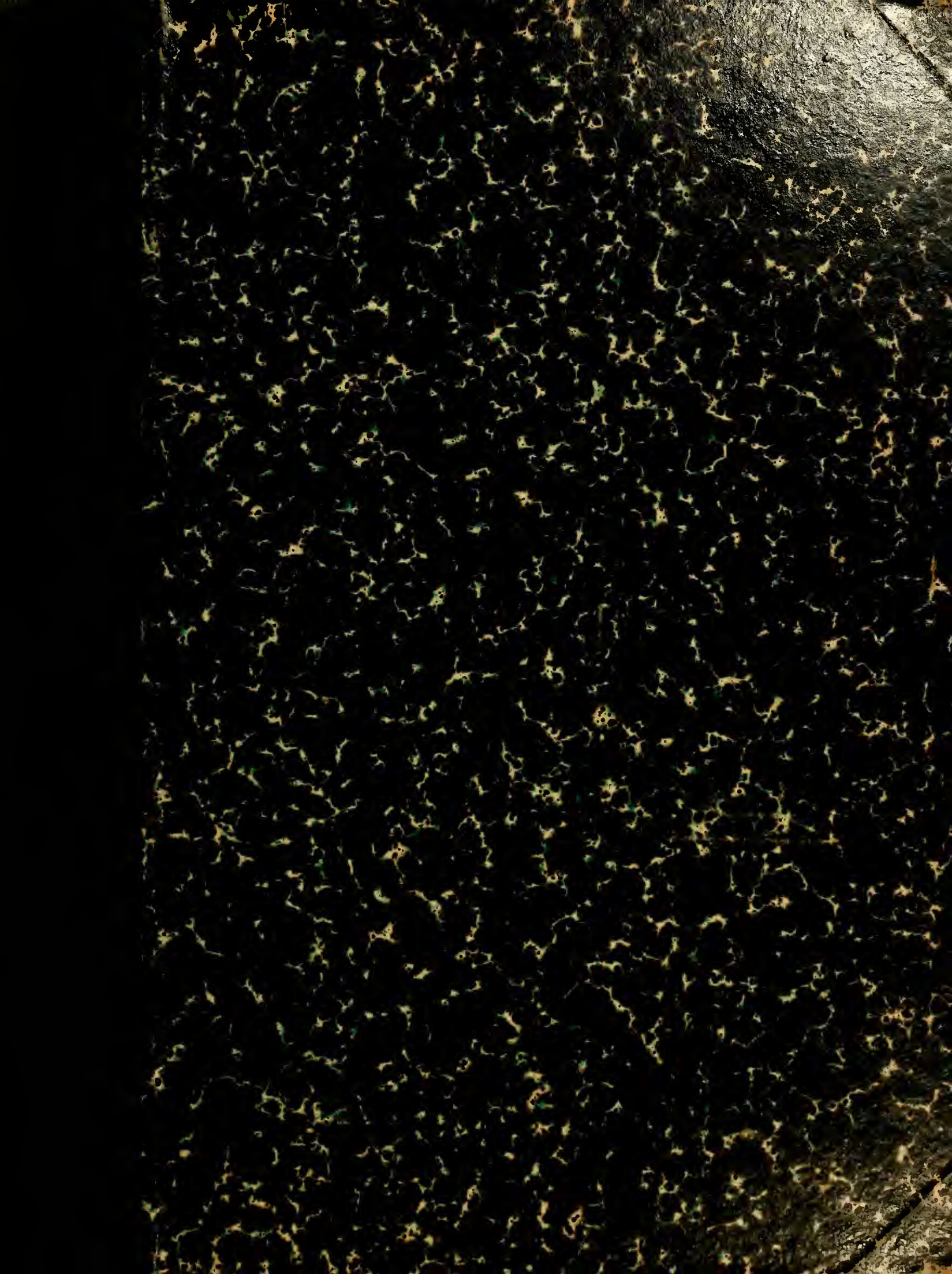

THE

TRANSACTIONS

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TRANSACTIONS

OF

THE LINNEAN SOCIETY.

BISCAYAN PLANKTON

COLLECTED DURING A CRUISE OF H.M.S. 'RESEARCH,' 1900.

PART I.—METHODS AND DATA.

(Plate 1.)

By G. HERBERT FOWLER, *B.A., Ph.D., F.L.S., F.Z.S.*

Read 21st January, 1904.

MARINE BIOLOGICAL LABORATORY WOODS HOLE LIBRARY MASS.

DURING the month of July, 1900, the Lords Commissioners of the Admiralty consented, at the request of the Council of the Royal Society, to place H.M.S. 'Research' at my disposal for an investigation of the Plankton of the Bay of Biscay. In this work I had the very great advantage of the voluntary assistance of my friend Mr. L. A. Borradaile, of Selwyn College, Cambridge, without which it would have been impossible to get through so much in the time at my disposal. My thanks are also due not only to the Lords of the Admiralty and to the Council of the Royal Society, but also to Admiral Sir W. J. Wharton, F.R.S., for his assistance in the matter, and to Captain A. M. Field and the other officers of the 'Research' for the ready and patient help which they rendered throughout the cruise.

The **area** studied was selected as being the nearest to Great Britain at which a depth of over 2000 fathoms could readily be obtained. It lay between 46° 43′ and 47° 29′ North latitude, and 7° 15′ and 8° 18′ West longitude. The stations were included in a parallelogram which measured roughly 78 by 20 nautical miles. Within so small an area, and at a considerable distance from land, there is no reason to suppose that the fauna and physical conditions are other than uniform throughout; and what is true of one extremity of the parallelogram may fairly be taken to hold good of the other end at the same moment. This identity of conditions was deliberately selected, for, as I have elsewhere maintained *, accurate information as to the constituents of the Mesoplanktonic

* Proc. Zool. Soc. 1898, pp. 567 *et seq.*

fauna is only possible by a comparison of numerous hauls taken at all depths in the same area at about the same date.

The special **problems**, with reference to which the hauls were planned, were (1) the vertical movement of the Epiplankton in relation to time of day, and, if possible, to such other varying conditions as rain, wind, and swell ; (2) the presence (or absence) in deep colder water of organisms known to occur at the surface in higher latitudes, but not represented in the warmer surface-waters of the Bay of Biscay. Until the Reports on the various groups of animals are finished, it will be impossible to say how far the attempt on these two problems has been successful ; but I venture to think that a glance at the table of hauls below (pp. 8–10) will show that a serious attempt has been made to attack them. In this first communication those working data of the cruise are published which will make subsequent Reports intelligible.

The **methods of collection** employed were : (1) ordinary open tow-nets (about 20 inches diameter, except net 180 which was 12 inches in diameter) towed by the ship's drift at the surface and at depths of 25, 50, 75, and 100 fathoms ; (2) the opening and closing Mesoplankton net which had been previously used with success by myself in the Færoe Channel, and by the Dutch 'Siboga' Expedition in the East Indies * ; (3) a Mesoplankton trawl, differing only from the latter in having a 4-foot-square mouth, and a bag made of pilchard-netting, 9 feet in length, but with the same arrangements for opening and closing ; (4) at the close of the cruise, open tow-nets bent on to a wire rope at intervals between 100 and 350 fathoms, after the serial method in use on H.M.S. 'Challenger,' for comparison with what I regard as the more certain method of a closing net. So far as I have observed, while the serial method brings on deck a very much larger quantity of material, its condition is often not so good as that from the closing nets.

On the question of the nets, some of my results may perhaps prove of use to other collectors on board ship.

(1) With hauls at the actual *surface* (since a long line is necessary to let the net go clear of the ship's refuse, and clinkers and potato-parings do not improve the Plankton) hemp rope and a float where the bridles of the net are attached to it, give the best results : even a fine wire has a tendency to sink the net to an uncertain depth, and wet cod-line cuts the hands painfully when hauled. With *deeper* Epiplankton hauls, down to 100 fathoms a small hand-winch and fine wire rope with a 19 lb. lead at the end gave excellent results ; but even with this weight the nets have a tendency to stream upwards and away from the vertical, and in drifting before a strong wind a net at the end of a 100-fathom wire may have towed anywhere between 100 and 70 fathoms. If the angle made by the visible wire, which may be 45° in a strong drift, were constant for the whole length of the wire, then

the 100-fathom mark would be at			70	fathoms,	
„	75	„	„	52	„
„	50	„	„	35	„
„	25	„	„	17	„

In using two nets at a time on the wire, and a 20 lb. lead, it is safer, except in a flat calm, to bend the nets on, not at the 100, 75, &c. marks, but at from 5 to 10 fathoms below these marks ; it is better to

* 'Siboga' Expeditie : Introduction et Description de l'Expédition, par Max Weber, p. 11. I may perhaps be pardoned for remarking that Prof. Weber speaks well of the net.

go too deep than too shallow. At the same time, as I have before shown *, the angle made by the visible wire in going over is *not* an accurate indication of the lie of the submerged wire: for example, during this cruise, on one occasion (hauls 35 *c* and *d*) my nets, streamed from the port quarter, fouled a sounding-wire with thermometers let go from the starboard bow; on discovering the foul, both wires were hauled, and both appeared to be straight up and down for many fathoms, although really foul of one another at 70 fathoms depth under the keel amidships.

Two attempts to improve the ordinary tow-nets are perhaps worth recording, although both were failures, since they may serve as warnings to other marine naturalists. In the one, a funnel of boulting-cloth hung down loosely into the net from the frame, to serve as a "pocket" which should keep the faster swimmers from escaping; its effect in practice was to prevent animals from getting into the net by diminishing the opening, rather than to keep them there. Another experiment was a funnel of boulting-cloth, which was fastened to the net just above the collecting-tin, the lower end hanging in the tin, with the idea of saving the organisms which get crushed in the angle between net and tin when the latter is lifted out of water: it was not a success.

(2) The Mesoplankton net, which was fully described in the Proc. Zool. Soc. for 1898, pp. 568–574, worked fairly well, but with 23 per cent. of failures: these were traced to easily remediable causes, notably to the net-frame being too light for the lock, if lowered fast or used in a heavy swell: these defects have been remedied in nets built subsequently for the Antarctic ship 'Discovery' and for Dr. Wolfenden.

(3) The Mesoplankton trawl, having a much heavier net-frame, worked quite satisfactorily as a machine, but caught so little, in comparison with the time occupied on deep hauls, that it was soon abandoned. It had been devised to catch large organisms, fish, and cephalopods, which escape the ordinary net owing to its small size and slow speed. I attribute its failure to catch more than it did, to its being still too small and hauled too slowly; it could only be heaved in at about 2 miles an hour, the maximum rate at which the winch hands could reel up the wire rope as delivered from the deck-engine. When touched, large animals seem to jump clear of a small net: I have therefore designed a 17-foot-square trawl to open and shut, which I hope may yield better results, if the winch is geared to the deck-engine.

The epiplankton nets were out for different periods of time, generally for about an hour. I think that uniform hauls of half an hour would have been better. In an hour more material is, of course, caught; but it seems to increase the number of specimens rather than of species, with the results that the condition of the material is not so good, and that the labour of sorting the catch, always tedious, becomes doubly so. In consequence, I have taken for identification only about half the material in many of the epiplankton hauls; from the other half have been taken conspicuous novelties, and organisms of which every specimen was desired for statistical (quantitative) study.

As regards *reagents* for dealing with the bulk of the catch, which remains when the larger specimens have been picked out, the chief thing to avoid is mercury bichloride: this forms a dirty, sticky, insoluble deposit all over the specimens, apparently consisting of an albuminous compound with mercury. My best results, on the whole, were got by adding a little pure formalin to kill, and when the animals had sunk to the bottom of the jar, by preserving in 3 per cent., followed by 5 per cent. solution of formalin in fresh water.

The details in Table I. are extracted from the ship's log. The force of the **wind** is expressed on Beaufort's scale, of which

1	represents a velocity of	8	miles	per	hour,
2	„	„	13	„	„
3	„	„	18	„	„
4	„	„	23	„	„

* Proc. Zool. Soc. 1898, p. 568.

As regards the state of the **sea**, it must be remembered that "smooth" in a sailor's mouth often covers enough swell to break Medusæ and Siphonophora to bits in the net, and to make it difficult to work deep-water nets.

The **depths** marked with a + were the greatest depths to which a net was lowered each day and found no bottom.

In Table II. are given the more variable data.

All the **hauls** were made with open tow-nets, except where only the time of arrival on board is given in the second column, these hauls being taken with the closing Mesoplankton net.

In the third column, headed **"Net,"** is given the number of meshes per linear inch: a matter of importance in dealing with minute animals. The nets were made of the ordinary Swiss Boulting Silk familiar to marine zoologists (except 65, which was of muslin).

The fourth column shows the **horizon** investigated. In the hauls marked 25, 50, 75, &c. to 0, the net was lowered, towed for some time at the lowest level, and pulled straight up to the surface again as rapidly as was safe. As has been pointed out above, these nets may have towed a little above the depth indicated, in some cases where the ship's drift was considerable; but I do not think that, used as they were on a $\frac{3}{8}''$ circumference wire rope with a 19-lb. sounding-lead, they are likely to have risen much above the theoretical depth.

As regards the deeper hauls, there were in the regular series:

7	hauls from	200	to	100	100-fathom sections,
3	„ „	300	„	200	
3	„ „	400	„	300	
3	„ „	500	„	400	
4	„ „	750	„	500	250-fathom sections,
5	„ „	1000	„	750	
3	„ „	1250	„	1000	
2	„ „	1500	„	1250	
2	„ „	2000	„	1500	500-fathom sections;

and also as extra hauls round a supposed "critical" depth, there were:

1 haul from 150 to 50,
1 „ „ 150 „ 100,
3 hauls „ 250 „ 150.

The collection may therefore be expected to yield a fair picture of the smaller Mesoplankton.

The actual **bulk of water** from which the fauna is strained by these deep-water nets is very small; and this point must not be forgotten when organisms are only occasionally captured, or seem few and far between in the deeper hauls. Thus with the ordinary 20-inch-square Mesoplankton net in the tables just given:

100-fathom section strains 1650 cubic feet,
250 „ „ 4125 „ „
500 „ „ 8250 „ „

of which even the last is less than the cubic contents of a fair-sized drawing-room, $20' \times 30' \times 14'$ high.

The total number of what I term **"comparable hauls"** with tow-nets is made up as follows :—

25	hauls at 0 fathoms	Epiplankton hauls with open tow-nets.
12	„ 25 „	
13	„ 50 „	
11	„ 75 „	
22	„ 100 „	
7	„ various depths, open serial tow-nets.	
37	„ „ „ closing Mesoplankton net.	
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These omit as "non-comparable" from the list in Table II., two hauls of which only part was kept (21 *d*, 21 *d'*), two miss-fires of the Mesoplankton net (27 *a*, 27 *a'*), three hauls of the trawl (29 *a*, 30 *a*, 30 *e*), and four hauls of which the specimens cannot at the moment be traced (*cf.* p. 11).

As regards the **temperatures**, we depended on the daily observations in the ship's log for the surface records. But as a Quartermaster's readings of a thermometer are not invariably accurate, I have generally taken a mean for each day as the safest approximation, and as sufficiently useful for zoological, although not for meteorological, work.

As regards the temperatures at 25, 50, and 75 fathoms, I regret to say that in the constant calls on my time in connection with the rest of the work, I entirely forgot to take any observations! The temperatures for these depths have, however, been supplied as mean values for July in this district by the kindness of Dr. Schott, of the Deutsche Seewarte in Hamburg.

The deep-sea temperatures are taken from a very complete series of observations which the officers of H.M.S. 'Research' were kind enough to make for me at the time. The thermometers used were of the Miller-Casella type, and included some special ones with a scale of twice the usual size. They were used on sounding-wire; attempts to use the $\frac{3}{16}$" diam. wire rope showed that the vibration of the rope jarred the indices down and rendered observations quite unreliable.

The actual observations were as follows, omitting those on the wire rope :—

Depths in Fathoms: Temperatures in Degrees Fahrenheit.

Fathoms ...	100	200	250	300	350	400	450	500	550	600	700	800	900	1000	1050	1100	1150	1200	1250	1500	1750	2000	2341
July 7th, 1900...	52·7	51·9	...	51·8	...	50·5	...	50·0	...	48·6	47·5	45·7	43·5	40·6	...	39·0	...	...	38·5	37·4	38·1	36·6	...
„ 7th, „ ...	...	52·0	51·7	51·5	50·8	50·1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
„ 11th, „ ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	36·5
„ 18th, „ ...	...	...	...	51·2	50·8	50·5	49·8	49·4	48·9	...	...	...	...	...	39·8	...	39·0	38·8	...	37·5	37·2	...	...
„ 24th, „ ...	...	...	...	...	...	...	...	...	...	...	46·8	...	41·7	40·0	39·7	39·2	38·6	38·5	...	...	...	...	...

These observations have been plotted into the curve marked I. in Pl. 1. Alongside of this has been plotted a curve, marked II., deduced from the much scantier observations

of H.M.S. 'Porcupine,' Station 38, 1869, position 47° 39′ N., 11° 33′ W., or about 150 miles W.N.W. of our usual position *; and the curve of mean ocean temperatures † has been placed alongside as III.

This last curve, plotted, as Dr. Buchan said, "from the whole of the observations in all latitudes for the different depths" recorded up to the date of his Report, may be taken as the standard curve for ocean temperatures where unaffected by specific causes. But curves I. and II., as compared with the regularity of III., show by a downward bow that between 200 and 1000 fathoms the water is much warmer than it should be according to the usually regular diminution of temperature. This is no doubt due largely to the influence of the Gibraltar bottom current. At the Straits of Gibraltar there is an upper inflow of colder water from Atlantic to Mediterranean, and a bottom outflow of warmer water from Mediterranean to Atlantic ‡: the influence of this warmer water is very conspicuous in the maps appended to Dr. Buchan's 'Challenger' Report, already cited, between 500 and 900 fathoms, as shown by a concentricity of the isobathytherms at these and intermediate depths with Gibraltar as a centre §. That the critical points of the 'Porcupine' curve are at higher horizons than those of the 'Research' curve, and that the curve as a whole is colder, is probably due to the more northerly position of the 'Porcupine' station and its greater distance from Gibraltar.

The letters in the sixth column under the head of **"Weather"** are taken from Beaufort's scale, and are as follows:—

B = blue sky.	O = overcast.
C = cloudy.	R = rain.
M = mist.	

Under the heading of **"Light"** in the log is recorded the number of seconds required to turn the sensitive paper of Wynne's Exposure Meter to a standard tint. This method of light-estimation was suggested to me by Mr. E. W. L. Holt: of course it records only actinic values, not absolute light; unfortunately it is practically useless at dawn and dusk, and is quite useless at night even when there is a considerable amount of non-actinic light.

With regard to the occasional presence in a deep haul of isolated specimens of animals captured otherwise only at higher horizons, it must be noted that while the nets were always washed out in fresh water after a haul, there is always a *possibility* of a small animal adhering to the net and appearing in the collecting-tin of a subsequent haul. Again, an animal from a previous haul may conceivably be left over on a dipping-tube or in a killing-bottle, and so stray into a later haul, in the haste which is often

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* Wyville Thomson: Depths of the Sea, pp. 143 & 321.

† A. Buchan: 'Challenger' Report on Oceanic Circulation, p. 9.

‡ 'Shearwater,' Proc. Roy. Soc. xx. p. 97.

§ This explanation has also been accepted within certain limits by Dr. Gerhard Schott ('Valdivia' Expedition, Oceanographic, p. 186).

inseparable from work of this kind at sea. However, with reasonable care such cases will be few in number, and will not materially affect the question of large percentages.

In some groups (Chætognatha, Ostracoda, &c.) an attempt will be made to give a quantitative estimate of the specimens captured, with a view to the study of their vertical oscillation. It is not contended that every single specimen of a minute Ostracod or *Doliolum* has been picked out of the more abundant hauls; the clots which Phæodarian Radiolarians often make, which cannot be disentangled without wrecking the specimens, are alone enough to prevent this—still, it has been attempted. The population-figures presented will therefore not be *absolutely* accurate, but will be, I believe, fairly proportionately correct. In any case, the error is greatest in the more populous hauls, and falls to zero in the less populous; its result will therefore be to *underestimate* the difference between abundance and scarcity of a species—if the figures were absolutely correct, the argument from the numbers captured would be stronger.

On pages 53, 54 will be found examples of a "time-depth" table, issued to the naturalists who are kind enough to report upon individual groups. It was drawn primarily with the idea of seeing whether a species rises by night and sinks by day, or not; but it serves also, as in these first instances, to exhibit graphically the horizons of capture in the Epiplankton and upper Mesoplankton. The ordinates are the twenty-four hours, the abscissæ are depths down to 400 fathoms (not proportional). Every "comparable" haul is set down at or near its intersection point, and the hauls in which a species was captured are printed in heavy type. All these hauls were made with open tow-nets, and ended at the surface, except those over which an arrow is placed: these latter were made with the closing Mesoplankton net, the length of the arrow indicating the section through which the net was open. Thus 32 *l* was a haul with the Mesoplankton net open between 400 and 300 fathoms, but 36 *l* began at 350 fathoms and was open to the surface.

It will be obvious from this table that the Epiplankton hauls were deliberately grouped round noon and midnight, round the surface and the 100-fathom line, as being supposed to be "critical." There is no reason to believe that the "diurnal" conditions, which have been alleged to produce a vertical oscillation of the Plankton, differ appreciably between (say) 6.0 A.M. when the sun is well up, and 6.0 P.M. when he has lost his power; and in the limited time at our disposal it seemed more judicious to concentrate the hauls at supposed critical points than to get a complete series of single hauls at every depth for every hour of day and night, which would probably not have been so significant.

I must not close this introduction without expressing my indebtedness for much practical help in matters of gear to Mr. W. P. Bullivant (Messrs. Bullivant and Co.), and to Mr. M. H. Gray (Telegraph Works Company, Silvertown).

Table I.

Hauls.	Date.	Position.		Wind.		Sea.	Observed depths, in fathoms.
		N. latitude.	W. longitude.	Direction.	Force.		
21 *a* to 21 *c* ..	7.vii.	47° 8′	7° 41′	N. by E.	2	Smooth.	+2000
21 *d* to 21 *i* ..	8.vii.	47° 4′	7° 53′	N.E.	2	,,	
21 *k* to 22 *g* ..	9.vii.	47° 11′	8° 11′	E.S.E.	2–3	,,	
23 *a* to 23 *e* ..	10.vii.	47° 29′	8° 18′	S.E.	3	Slight swell.	1219
24 *a* to 24 *k* ..	11.vii.	47° 5′	7° 45′	N.E.	2–3	Smooth.	2341
25 *a* to 25 *l* ..	12.vii.	46° 59′	7° 46′	N.N.W. to N.	1–2	Calm.	+2000
26 *a* to 26 *f* ..	13.vii.	46° 59′	7° 29′	S.W.	2–4	Smooth, with occa-	+2000
27 *a* to 27 *c* ..	14.vii.	46° 54′	7° 26′	S.W.	1	sional large swells.	+1250
29 *a*	18.vii.	47° 9′	7° 44′	E.	3	Slight swell.	+1750
30 *a* to 30 *m* ..	19.vii.	47° 14′	7° 58′	S.S.W.	2	Smooth.	+2000
31 *a* to 31 *d* ..	20.vii.	47° 15′	7° 41′	W.	2–4	Moderate swell.	+1250
32 *a* to 32 *p* ..	21.vii.	47° 0′	7° 38′	S.W.	0–1	Slight swell.	+1000
33 *a* to 33 *h* ..	22.vii.	47° 2′	7° 24′	N.W.	1	Moderate swell.	+ 750
34 *a* to 34 *h* ..	23.vii.	46° 43′	7° 15′	N.E.	1–2	Smooth.	+ 750
35 *a* to 35 *y* ..	24.vii.	47° 8′	7° 54′	E. to N.E.	1–2	,,	+1200
36 *a* to 36 *l* ..	25.vii.	47° 3′	7° 55′	N.E.	1	,,	

Table II.

Haul.	Hour.	Net.	Horizon, in fathoms.	Temperature: Fahrenheit.	Weather.	Light, in seconds.
21 *a*	arr. 12.15 P.M.	45	200 to 0	52 to 61	B C	
21 *b*.....	arr. 4.0 P.M.	36	200 to 100	52	B C	
21 *c*.....	arr. 5.50 P.M.	36	300 to 200	51 to 52	B C	
21 *d* †....	9.15 A.M.	18	100 to 0	52 to 62	O C	11
21 *d'* †....	11.30 A.M.	18	100 to 0	52 to 62	B	2
21 *e*.....	1.30 to 2.0 P.M.	60	0	62	B	2
21 *f*.....	2.30 to 3.30 P.M.	180	0	62	B	2
21 *g*.....	4.0 to 4.30 P.M.	60	50 to 0	52 to 62	B	3
21 *h*.....	6.0 to 6.30 P.M.	60	100 to 0	52 to 62	B	6 to 7
21 *i*.....	11.30 P.M. to midnight	18	0	62	B	Bright moon.
21 *k*	arr. 12.0 noon	36	400 to 300	50 to 51	B C	
21 *l*.....	10.30 to 11.30 A.M.	60	100 to 0	52 to 63	B	4
21 *m*	arr. 1.15 P.M.	36	500 to 400	49 to 50	B	
21 *n*	arr. 1.30 P.M.	36	150 to 100	52	B	4
21 *o*	arr. 2.0 P.M.	36	200 to 100	52	B	
21 *p*	arr. 2.30 P.M.	36	150 to 50	52	B	4
22 *a*	2.25 to 4.0 P.M.	60	100 to 0	52 to 63	B	4 to 6
22 *b*.....	arr. 5.45 P.M.	36	750 to 500	46 to 49	B	
22 *c* †	8.30 to 9.30 P.M.	60	0	63	B	
22 *d*	10.15 to 10.40 P.M.	60	0	63	B	Bright moon.
22 *e*.....	10.20 to 10.40 P.M.	180	0	63	B	,, ,,
22 *f* †	10.40 to 11.15 P.M.	60	0	63	B	,, ,,
22 *g*	11.30 P.M. to midnight	18	0	63	B	,, ,,
23 *a*	arr. 12.15 P.M.	36	1000 to 750	40 to 46	B	
23 *b*.....	2.10 to 3.10 P.M.	60	0	63	B C	3
23 *c*.....	2.10 to 3.10 P.M.	180	0	63	B C	3
23 *d*	3.20 to 4.20 P.M.	60	0	63	O C	10
23 *e*.....	4.40 to 6.0 P.M.	60	0	63	B	6
24 *a*	arr. 9.30 A.M.	36	1250 to 1000	38 to 40	O C	

TABLE II. (*continued*).

Haul.	Hour.	Net.	Horizon, in fathoms.	Temperature: Fahrenheit.	Weather.	Light, in seconds.
24 *b*	9.30 to 10.30 A.M.	60	100 to 0	52 to 63	O C	8
24 *c*.....	11.30 A.M. to 1.0 P.M.	180	0	63	B C	10 to 6·5
24 *d*	11.30 A.M. to 1.0 P.M.	18	100 to 0	52 to 63	B C	10 to 6·5
24 *e*.....	1.15 to 2.30 P.M.	60	100 to 0	52 to 63	O C	6·5 to 13
24 *f*.....	3.30 to 4.30 P.M.	60	0	63	O R	13
24 *g*	5.0 to 6.0 P.M.	60	0	63	O R	14 to 22
24 *h*	5.15 to 6.10 P.M.	180	0	63	O C	14 to 22
24 *i*.....	12.15 P.M. to 1.15 A.M.	60	0	63	O C	Weak moon.
24 *k*	12.15 P.M. to 1.15 A.M.	180	0	63	O C	Weak moon.
25 *a*.....	9.35 to 11.35 A.M.	180	0	63	B C	6·5 to 2·5
25 *b*.....	11.35 A.M. to 12.35 P.M.	60	0	63	B	2·5
25 *c*.....	arr. 11.45 A.M.	36	2000 to 1500	36 to 37	B	
25 *d*	1.45 to 2.45 P.M.	60	100 to 0	52 to 63	B	2·5
25 *e*.....	4.0 to 5.0 P.M.	60	50 to 0	52 to 63	B	3 to 6
25 *f*.....	arr. 5.0 P.M.	36	1500 to 1250	37 to 38	B	
25 *g*	6.30 to 7.30 P.M.	60	50 to 0	52 to 63	B	7 to ∞
25 *h*	6.30 to 7.30 P.M.	65	0	63	B	7 to ∞
25 *i*.....	10.30 to 11.30 P.M.	65	0	63	B	Clear moon.
25 *k*	2.0 to 3.0 A.M.	60	50 to 0	52 to 63	B	" "
25 *l*.....	2.0 to 3.30 A.M.	65	0	63	B	" "
26 *a*	9.0 to 10.0 A.M.	60	25 to 0	54 to 63	B C	5·5
26 *b*.....	arr. 10.30 A.M.	36	2000 to 1500	36 to 37	B C	
26 *c*.....	10.0 to 11.0 A.M.	60	50 to 0	52 to 63	B C	7
26 *d* †....	arr. 2.0 P.M.	36	100 to 0	52 to 63	C	
26 *e*.....	arr. 3.0 P.M.	36	200 to 100	52	O	
26 *f*.....	arr. 4.45 P.M.	36	300 to 200	51 to 52	O	
27 *a* †....	arr. 9.10 A.M.	45	1250 to 0	38 to 63	O C	
27 *a'* †....	arr. 1.30 P.M.	45	1250 to 0	38 to 63	O C	
27 *b*.....	arr. 5.0 P.M.	45	1250 to 1000	38 to 40	B	
27 *c*.....	arr. 7.40 P.M.	45	1000 to 750	40 to 46	B	
29 *a* †....	arr. 6.30 P.M.	trawl	500 to 250	49 to 51	B	
30 *a* †....	arr. 6.30 A.M.	trawl	1500 to 750	37 to 46	B	
30 *b*.....	8.15 to 9.15 A.M.	60	25 to 0	54 to 64	B	4 to 3·5
30 *c*.....	9.15 to 10.15 A.M.	65	0	64	B	3·5
30 *d*	9.45 to 10.30 A.M.	60	50 to 0	52 to 64	B	3·5
30 *e* †....	arr. 10.30 A.M.	trawl	2000 to 1000	36 to 40	B	
30 *f*.....	11.0 A.M. to noon	60	75 to 0	52 to 64	B	3
30 *g*.....	1.0 to 2.0 P.M.	60	100 to 0	52 to 64	B	3 to 5·5
30 *h*.....	3.30 to 4.30 P.M.	60	100 to 0	52 to 64	O C	5
30 *i*.....	arr. 4.0 P.M.	45	1500 to 1250	37 to 38	O C	
30 *k*	arr. 6.30 P.M.	45	750 to 500	46 to 49	O C	
30 *l*.....	10.30 to 11.30 P.M.	60	50 to 0	52 to 64	B	Clear, but no moon.
30 *m*	10.30 to 11.30 P.M.	65	25 to 0	54 to 64	B	Clear, but no moon.
31 *a*	11.30 P.M. to 12.30 A.M.	65	25 to 0	54 to 64	O C R	Dark.
31 *b*.....	11.30 P.M. to 12.30 A.M.	60	50 to 0	52 to 64	O C R	Dark.
31 *c*.....	arr. 8.0 A.M.	45	1250 to 1000	38 to 40	O C	
31 *d*	arr. 5.0 P.M.	45	1000 to 750	40 to 46	O C	
32 *a*.....	4.15 to 5.15 A.M.	60	50 to 0	52 to 64	B C	45 to 13
32 *b*.....	4.15 to 5.15 A.M.	65	25 to 0	54 to 64	B C	45 to 13
32 *c*.....	4.15 to 4.45 A.M.	180	0	64	B C	45 to 26·5
32 *d*	5.30 to 6.30 A.M.	60	100 to 0	52 to 64	B C	12 to 13
32 *e*.....	5.30 to 6.30 A.M.	65	25 to 0	54 to 64	B C	12 to 13
32 *f*.....	arr. 11.30 A.M.	45	1000 to 750	40 to 46	B C	
32 *g*.....	12.30 to 1.30 P.M.	60	75 to 0	52 to 64	O C	5
32 *h*.....	12.30 to 1.45 P.M.	65	50 to 0	52 to 64	O C	5
32 *i*.....	2.30 to 3.30 P.M.	60	100 to 0	52 to 64	O C	5
32 *k*	arr. 3.0 P.M.	45	1000 to 750	40 to 46	O C	
32 *l*.....	arr. 7.10 P.M.	45	400 to 300	50 to 51	O C	

TABLE II. (*continued*).

Haul.	Hour.	Net.	Horizon, in fathoms.	Temperature: Fahrenheit.	Weather.	Light, in seconds.
32 *m*	10.30 to 11.30 P.M.	65	75 to 0	52 to 64	O C	
32 *n*	10.30 to 11.30 P.M.	60	100 to 0	52 to 64	O C	
32 *o*.....	midnight to 1.15 A.M.	65	75 to 0	52 to 64	O C	Very dark.
32 *p*	midnight to 1.30 A.M.	60	100 to 0	52 to 64	O C	
33 *a*	1.30 to 2.15 A.M.	180	0	65	O C	
33 *b*.....	2.30 to 3.0 A.M.	18	0	65	O C	Just before dawn.
33 *c*.....	11.15 A.M. to 12.30 P.M.	60	50 to 0	52 to 65	O C	
33 *d*	7.30 to 8.30 P.M.	60	100 to 0	52 to 65	O C	
33 *e*.....	7.30 to 8.30 P.M.	65	25 to 0	54 to 65	O C	
33 *f*.....	8.30 to 9.30 P.M.	60	50 to 0	52 to 65	O C	
33 *g*.....	8.30 to 9.30 P.M.	65	25 to 0	54 to 65	O C	
33 *h*.....	9.45 to 10.30 P.M.	60	75 to 0	52 to 65	O C	Dark.
34 *a*	1.30 to 2.30 A.M.	65	25 to 0	54 to 65	B	Very dark,
34 *b*.....	1.30 to 2.30 A.M.	60	100 to 0	52 to 65	B	but clear.
34 *c*.....	3.0 to 4.0 A.M.	65	75 to 0	52 to 65	B C	Grey to light.
34 *d*	3.0 to 4.0 A.M.	60	100 to 0	52 to 65	B C	
34 *e*.....	arr. 8.0 A.M.	45	750 to 500	48 to 49	O	
34 *f*.. ...	arr. 12.45 P.M.	45	750 to 500	48 to 49	O	
34 *g*	12.30 to 1.45 P.M.	60	25 to 0	54 to 65	O C	
34 *h*	arr. 7.0 P.M.	45	200 to 100	52	O C	
35 *a*.....	2.30 to 3.30 A.M.	65	75 to 0	52 to 65	O C	Dark to light.
35 *b*.....	2.30 to 3.30 A.M.	60	100 to 0	52 to 65	O C	
35 *c*.....	3.45 to 4.15 A.M.	65	75 to 0	52 to 65	O C	
35 *d*	3.45 to 4.30 A.M.	60	100 to 0	52 to 65	O C	
35 *e*.....	7.0 to 8.0 A.M.	65	75 to 0	52 to 65	O C M	6·5
35 *f*.....	7.0 to 8.0 A.M.	60	100 to 0	52 to 65	O C M	6·5
35 *g*†	8.15 to 9.15 A.M.	60	50 to 0	52 to 65	O C M	6·5
35 *h*	arr. 8.10 A.M.	45	500 to 400	49 to 50	O C M	
35 *i*.....	arr. 9.30 A.M.	45	500 to 400	49 to 50	O C M	
35 *k*	arr. 10.45 A.M.	45	400 to 300	50 to 51	O C M	
35 *l*.....	arr. 12 noon	45	300 to 200	51 to 52	O C M	
35 *m*	arr. 12.35 P.M.	45	200 to 100	52	O C M	
35 *n*	arr. 2.15 P.M.	45	200 to 100	52	O C M	
35 *o*.....	arr. 3.15 P.M.	45	250 to 150	52.	O C M	
35 *p*	arr. 4.15 P.M.	45	250 to 150	52	O C M	
35 *s*.....	arr. 5.15 P.M.	45	250 to 150	52	O C M	
35 *t*.....	arr. 6.5 P.M.	45	200 to 100	52	O C M	
35 *w*	6.0 to 6.55 P.M.	60	25 to 0	54 to 65	O C M	Too little to be
35 *x*	7.0 to 8.0 P.M.	60	100 to 0	52 to 65	O C M	recorded by the
35 *y*	7.0 to 8.0 P.M.	65	75 to 0	52 to 65	O C M	actinometer.
36 *a*	11.30 P.M. to 12.30 A.M.	65	75 to 0	52 to 66	O C	
36 *b*.....	11.30 P.M. to 12.30 A.M.	60	100 to 0	52 to 66	O C	Very dark.
36 *c*.....	12.45 P.M. to 1.45 A.M.	65	25 to 0	54 to 66	O C	
36 *d*	12.45 P.M. to 1.45 A.M.	60	50 to 0	52 to 66	O C	
36 *e*.....	9.15 to 11.45 A.M.	65	100 to 0	52 to 66	O C	
36 *f*.....	9.15 to 11.45 A.M.	60	150 to 0	52 to 66	O C	
36 *g*	9.15 to 11.45 A.M.	45	200 to 0	52 to 66	O C	
36 *h*	9.15 to 11.45 A.M.	36	250 to 0	52 to 66	O C	5 to 4
36 *i*.....	12.30 to 2.30 P.M.	60	250 to 0	52 to 66	O C	
36 *k*	12.30 to 2.30 P.M.	45	300 to 0	51 to 66	O C	
36 *l*.....	12.30 to 2.30 P.M.	36	350 to 0	50 to 66	O C	

NOTES TO TABLE II.

Hauls marked with a † are not reckoned as "comparable."

I regret to say that no bottles with the labels 22 *c*, 22 *f*, 26 *d*, 35 *g* could be found when the collection came to be sorted. They may have been thrown away at once and no record kept of the fact, or, I tremble to think, have been mixed with an adjacent haul. One can infer from the recorded times of hauling that in the case of 22 *c* and 22 *f* they can at most only have been mixed with 22 *d*, 22 *e*, or 22 *g*, if the mistake was made at the time ; and as all are from the surface and at night, no great damage will have been done. Similarly 26 *d* may have been mixed with 26 *e*, and 35 *g* with 35 *h* or 35 *i*. In these two latter cases I think that they would eventually show up when the collections have been worked out. In the meantime I can only plead that it is not easy for two men to keep nets going, sometimes for twenty-four hours in the day, without making an occasional mistake.

Another error was the labelling of a bottle 31 *n*, no such haul having been made. From a series of inferences unnecessary to detail, I believe this bottle to contain merely the conspicuous, separately-preserved organisms of 32 *n*. It has been issued as 32 *n'*, and will be treated in the percentages as a part of 32 *n*.

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21 *d*, 21 *d'*. These were hauled at once, not towed : only part of the catch was preserved.

22 *c*, 22 *f*. No bottles to be found with these labels.

23 *a*. The net-mouth was very slightly open. This seemed to have occurred in the last few fathoms, owing to the rapid laying up of the wire at the end of the haul.

25 *c*. Stopped in the middle of the haul to put another turn on the drum of the engine-winch : collecting-tin showed no visible life.

25 *d*, 25 *e*. There is some doubt whether 25 *e* is not really a part of 25 *d*.

26 *b*. Owing to a collision in the middle of this haul, the net was open for about an extra twenty minutes.

26 *d*. No bottle was to be found with this label.

27 *a*, 27 *a'*. Owing to a heavy swell, the net failed to close.

27 *c*. Collecting-tin contained no visible life.

29 *a*, 30 *a*. Mesoplankton trawl.

30 *b*, 30 *c*. Heavy rain and thunder overnight.

30 *e*. Mesoplankton trawl.

32 *k*. The deepest haul in which anything was noticed to be alive.

35 *c*, 35 *d*. Nets fouled thermometer-wire : not all the catch was saved.

35 *g*. No bottle was to be found with this label.

36 *e* to 36 *l*. Open serial tow-nets.

CURVES OF TEMPERATURES ACCORDING TO DEPTH.

BISCAYAN PLANKTON.

Part II.—THE AMPHIPODA AND CLADOCERA,

WITH NOTES ON A LARVAL THYROSTRACAN.

(Plates 2 & 3.)

By the Rev. T. R. R. Stebbing, *M.A., F.R.S., F.L.S., F.Z.S.*

AND AN APPENDIX ON THEIR DISTRIBUTION.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S., F.Z.S.*

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Amphipoda, Cladocera, and a larval Thyrostracan from the Bay of Biscay.

The small crustaceans which form the subject of the present report, when entrusted to my examination by Dr. G. H. Fowler, were contained in 121 tubes, and have proved to belong to 29 distinguishable, if not in every case determinable, species. Four of these are Amphipoda Gammaridea, nineteen Amphipoda Hyperiidea, two Cladocera, two Ostracoda (discussed elsewhere), one the larva of a Cirripede, and one an Isopod, probably belonging to the genus *Eurycope*, but too fragmentary for determination. One of the Gammarids, though clearly distinct from the rest, was too imperfect for description. Of the remaining Gammarids one is a very common and one a rare species; the third is new and supplies the representative of an interesting new genus. Among the Hyperiids the family Scinidæ is represented by no less than eight species, two of them requiring the institution of new genera. In the family of the Hyperiidæ, *Hyperioides longipes*, Chevreux, calls for special remark. It far exceeds in the number of its occurrences and in number of specimens any other species of Amphipoda in this collection. Yet this apparently common form was not described, at any rate from the Atlantic, until the year 1900. To the description by Chevreux speedily followed an obviously independent account by Dr. Vosseler, and now in quick succession the same species appears as a predominant constituent of Dr. Fowler's collections.

The present opportunity has been taken for making more generally known the characters of the juvenile *Primno* among the Hyperiids, and the external appearance of the *Cypris*-larva of *Lepas pectinata* among the Thyrostraca.

AMPHIPODA GAMMARIDEA.

Fam. Lysianassidæ.

Cyphocaris, Boeck, 1871.

1871. *Cyphocaris*, Boeck, Vid.-Selsk. Forhandl. (Christiania) for 1870, p. 103 (23).
1888. *Cyphocaris*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. pp. 398, 656.
1900. *Cyphocaris*, Chevreux, Amphipodes de l'Hirondelle, p. 165.

It does not appear that Lütken took any part in the definition of this genus, although, according to Boeck, he chose its name. It was therefore, as I now think, an error of judgment on my part to name Lütken and Boeck as joint founders of the genus.

1. Cyphocaris anonyx, Boeck.

1871. *Cyphocaris anonyx*, Boeck, Vid.-Selsk. Forhandl. (Christiania) for 1870, p. 104 (24).
1872. *Cyphocaris anonyx*, Boeck, Skand. og Arkt. Amphipoder, vol. i. p. 141, pl. 6. fig. 1.
1888. *Cyphocaris micronyx*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 656, pl. 16.
1890. *Cyphocaris micronyx*, Chevreux, Amphipodes de l'Hirondelle, p. 165.
1903. *Cyphocaris anonyx*, A. O. Walker, Ann. & Mag. Nat. Hist. ser. 7, vol. xii. p. 232, pl. 18. fig. 14.

The points in which the descriptions of *C. anonyx* and *C. micronyx* differ are fully sufficient for specific distinction, but they seem little worth insisting on until fresh specimens have been obtained corroborating the earliest description. *C. anonyx* was found

in Greenland waters, and while *C. micronyx* was known from no nearer habitat than Tristan da Cunha, the distinctness of the two species had a sort of geographical support. This, however, is greatly weakened by the finding of *C. micronyx* in the Bay of Biscay, and the earlier report of its capture by the Prince of Monaco's yacht l'Hirondelle at 47° 38′ 13″ N., 22° 13′ 40″ W.

Occurrences: 21 *k*. 300 to 400 fathoms. 1 specimen.
32 *l*. 300 to 400 fathoms. 1 specimen.

Fam. Eusiridæ.

Eusirogenes, n. g.

In general agreement with *Eusirus*, but with the head arching over the base of the first antennæ, distal margin of the upper lip straight, third joint of mandibular palp shorter than second, inner plates of the maxillipeds completely separate, second gnathopods much smaller than first, the fifth joint in both pairs proximally elongate with the cup-forming process little developed.

2. Eusirogenes dolichocarpus, n. sp. (Plate 2 A.)

Though the solitary specimen on which the new genus and species are founded was both defective and damaged, a sufficient number of important features were in satisfactory condition. The flagellum of the second antennæ, the third and fourth peræopods and the three terminal joints of the first, second, and fifth pairs, the third uropods, and the telson were entirely missing. The thin papyraceous integument was crumpled, making it difficult to determine the exact relative positions of the side-plates. Nor could their several shapes and sizes be determined prior to dissection. The back of the peræon appeared to be rounded, not carinate, with little difference in length between the segments. Of the pleon-segments the first three were much longer, the second and third much deeper, than those of the peræon. The postero-lateral angles of the third segment are smoothly rounded, not serrate; the fourth is longer than the fifth and sixth combined, and has a saddle-like dorsal depression. On this and each of the three preceding segments there seemed to be one or two postero-dorsal denticles, but these were minute and it was not possible to determine whether they terminated carinæ or mere accidental folds of the pellucid skin.

The mouth-organs were in good order, but collectively were most likely out of position, since the whole mass pointed downwards at right angles to the head, with the long palps of the mandibles projecting fantastically between the gnathopods. The head itself was opaque, longer than wide, without rostrum, though the curved sides of its triangular form ended in a minute point. Beyond the base of the first antennæ it was hollowed into an arch. It must, however, be borne in mind that the oral parts, though firmly knit together among themselves, showed signs of a forcible dislocation by which the cephalic framework may have had its appearance seriously modified.

Of eyes no trace was observable.

First antennæ.—First joint rather long, with strong distal tooth on the inner side,

second joint a little shorter, third short; flagellum of 31–34 joints, about thrice as long as peduncle, with subapical setules, which on the joints of the proximal half form short fringes. Accessory flagellum consisting of a single spine-like joint, about three-fourths as long as the second of the peduncle.

Second antennæ.—The gland-cone is very prominent on a very short joint. The two following joints are slender, the first half as long as the second, the latter nearly as long as the first of the first antennæ.

Upper lip.—Distal margin straight and smooth in centre, at each end slightly rounded and hirsute.

Mandibles.—Cutting-edge and secondary plate not very broad, the teeth small; spine-row of four spines; molar moderately powerful, a denticulate oval not occupying the whole of the crown; palp elongate, set well forward; first joint short, second considerably longer than the third.

First maxillæ.—Inner plate seemingly very slight; outer plate with ten spines, some of which have a lateral denticle; first joint of palp scarcely half as long as second, the latter apically fringed with setæ.

Second maxillæ.—Inner plate short, the rounded apex fringed with a few short spinules; the outer plate little more than half as broad, with several long apical spines.

Maxillipeds.—Inner plates not partially coalesced as in *Eusirus*, their apical spines slender; outer plates little broader, their spines slender; second, third, and fourth joints of palp elongate, subequal in length.

First gnathopods.—Second joint long, distally narrowed, channelled in front, third and fourth joints short, fifth nearly as long as second, its long narrow stem widening to the commencement of the shallow cup in which the trapezoidal hand reposes. The powerful hand, or sixth joint, has four unequal margins, the front one, to the base of which the fifth joint is attached, being the shortest. The longest is the palmar margin, a horny-looking strip fringed with little spinules; the finger is attached at its base and with curved apex overlaps its distal end, on which are planted two spines, one long, the other short. The other two margins, which meet in a rounded obtuse angle, perhaps together represent the hind margin of this muscular joint.

Second gnathopods.—These are distinguished from the first by having several long setæ on the hind margin of the second and fifth joints, by having the stem of the latter considerably wider, the hand and finger very much smaller, the palm more convex and not overlapped by the finger. Also, the stem of the fifth joint, instead of being not much longer than the part which forms the cup, is here nearly two and a half times as long. In both pairs the finger is shaped to correspond with the palmar margin.

First and second peræopods.—Extremely slender; second joint elongate, third short, fourth (in second pair) long, but much shorter than the second.

Third peræopods.—The side-plates of this pair are very unequally bilobed.

Fifth peræopods.—The second joint is little longer than broad, with a slight narrowing distally: the fourth joint is a little longer, slender, slightly curved.

Pleopods.—Peduncle carrying two small coupling-hooks; the first joint of inner ramus armed with five cleft spines, this ramus (in one pair) having fourteen joints, and the outer fifteen.

First uropods considerably longer than second; peduncle longer than the rami, which, however, are long and slender, with small spines along both margins and some microscopic pectination, the outer ramus the shorter.

In the second pair the inner ramus is subequal in length to that of the first pair, longer than its peduncle, and much longer than the outer ramus.

Length, from apex of head to end of fifth pleon-segment, 7·5 mm., so that the length to the end of the uropods, but exclusive of the antennæ, may be estimated at over 10 mm.

As the net (the mesoplankton trawl) was hauled fast, with a view of capturing large organisms, it is not surprising that the specimen was damaged.

While the generic name refers to the probable evolution of this genus from *Eusirus*, the specific name, meaning "long-wristed," alludes to the character of the fifth joint in both pairs of gnathopods, differentiating this form from all previously known Eusiridæ.

Occurrence: 30 *e*, mesoplankton trawl. 2000 to 1000 fathoms. 1 specimen.

Fam. Ischyroceridæ.

Jassa, Leach.

1814. *Jassa*, Leach, Edinburgh Encyclopædia, vol. vii. p. 433 (Art. Crustaceology, Appendix).
1899. *Jassa*, Stebbing, Ann. & Mag. Nat. Hist. ser. 7, vol. iii. p. 237.

3. Jassa pulchella, Leach.

1814. *Jassa pulchella*, Leach, Edinburgh Encyclopædia, vol. vii. p. 433.
1894. *Podocerus falcatus*, Sars, Crustacea of Norway, vol. i. pt. 27, p. 594, pl. 212.
1899. *Jassa pulchella*, Stebbing, Ann. & Mag. Nat. Hist. ser. 7, vol. iii. p. 239.

A discussion of the synonymy of this abundant and well-known species will be found in the 'Annals and Magazine of Natural History' above cited, and an excellent description in Sars's great work on the Crustacea of Norway. The celebrated Norwegian author speaks of the "last pair of uropoda with the inner ramus distinctly hooked." According to my observation it is not the inner but the outer ramus that is hooked.

Occurrences: 24 *f*. 0 fathoms. 3 small specimens.
24 *i*. 0 fathoms. 2 specimens and a fragment.

AMPHIPODA HYPERIIDEA.

The first three families of this division may conveniently be distinguished by the following synoptic table:—

1.	Mandibles with molar; fingers of fifth peræopods obtuse	3. Vibiliidæ.
	Mandibles without molar; fingers of fifth peræopods acute.	2.
2.	Fingers of third, fourth, and fifth peræopods not retractile	1. Scinidæ.
	Fingers of third, fourth, and fifth peræopods retractile	2. Lanceolidæ.

A valuable table for the families of the Hyperiidea at large is supplied by Bovallius in the first part of his monograph on the group, published in 1887.

Fam. Scinidæ.

1849. *Corophidæ* (part.), Dana, Amer. Journ. Sci. ser. 2, vol. viii. p. 140.
1853. *Corophidæ* (subfam. *Clydoninæ*), Dana, U.S. Expl. Exp. vol. xiii. pp. 829, 831.
1862. *Corophiidæ* (subfam. *Corophiides*), Bate, Brit. Mus. Catal. Amph. pp. 233, 273.
1862. *Hyperidæ*, Bate, Brit. Mus. Catal. Amph. p. 308.
1877. *Corophiidæ* (subfam. *Clydoninæ*), Streets, Contributions Nat. Hist. Hawaiian and Fanning Islands and Lower California, p. 124.
1882. *Clydoniidæ*, Sars, Christiania Vidensk. Forhandlinger, No. 18, p. 20.
1887. *Tyronidæ*, Bovallius, Bihang t. K. Svensk. Vet.-Ak. Handl. Bd. xi. No. 16, p. 3; K. Svensk. Vet.-Ak. Handlingar, Bd. xxi. No. 5, p. 3.
1888. *Scinidæ*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1270.
1889. *Fortunatæ*, Chun, Math. u. Naturw. Mittheilungen Ak. Berlin, Bd. xlv. p. 535 (345).
1889. *Scinidæ*, Chun, Zool. Anzeiger, xii. Jahrg. pp. 286, 308.
1890. *Scinidæ*, Sars, Crustacea of Norway, vol. i. p. 18.
1895. *Scinidæ*, Stebbing, Trans. Zool. Soc. London, vol. xiii. pt. 10, p. 349.
1896. *Scinidæ*, Garbowski, Denkschr. k. Akad. Wiss. Bd. lxiii. (Ber. Comm. Erforsch. östl. Mittelmeeres, fünfte Reihe, p. 39).
1900. *Scinidæ*, Chevreux, Amphipodes de l'Hirondelle, p. 121.
1901. *Scinidæ*, Vosseler, Amphipoden der Plankton-Exp. pt. i. p. 100.

Head usually broader than long, with eyes, when present, small and distant. Pleon narrower than peræon, its fifth and sixth segments coalesced, and telson small. First antennæ large, tapering, with little flexibility, attached at the front corners of the head. Second antennæ attached below and behind the first, variable with age and sex. Mandibles without molar. First and second maxillæ well developed. First and second gnathopods simple, slender. Of peræopods usually third pair longest and fifth shortest; fingers acute, not retractile. Inner branch of uropods usually coalesced with the peduncle.

The definition of the family is here modified to admit the new genus *Archæoscina*, which has a mandibular palp, and the new genus *Parascina*, in which the maxillæ are distinctive and the uropods show a clear demarcation between inner ramus and peduncle. Future discoveries will probably justify the withdrawal of *Archæoscina* from its present position to form the type of a new family Archæoscinidæ. For the present the genera of Scinidæ may be distinguished as follows:—

1. Mandibles with palp . . . . . 1. *Archæoscina*.
   Mandibles without palp. 2.
2. Palp of first maxilla extremely broad, inner plate of second maxilla broader than outer . . . . . 2. *Parascina*.
   Palp of first maxilla not very broad, inner plate of second maxilla narrower than outer. 3.
3. Dorsal carina produced into teeth . . . . . 3. *Acanthoscina*.
   Segments of trunk without dorsal teeth . . . . . 4. *Scina*.

Acanthoscina was instituted by Vosseler in 1901 for a species, *A. serrata*, which he supposed to be new. Dr. Vosseler happened at the time to be unacquainted with *Scina acanthodes*, Stebbing, published in the Trans. Zool. Soc. London, in 1895. This he has since recognized as identical with his own *A. serrata*, and therefore as the type of his new genus.

Archæoscina, n. g.

In general habit and in the appendages of peræon and pleon like *Scina*.

First antennæ short and thick; second slender, straight, ending in an elongate spine. Mandibles with a three-jointed palp, in which the third joint is much the longest. All three pairs of uropods with the outer branch well developed, longer than the peduncle.

In regard to the above definition, it may be observed that the first antennæ have the form found in the young of species evidently belonging to *Scina*. It is also probable that the long inner branch of each uropod is jointed to the peduncle, but this feature is not exhibited with sufficient clearness in the only available specimen to be relied on as a generic character. Should it be in future more positively ascertained, it will strengthen the inference, drawn from the presence of a mandibular palp, that *Archæoscina* is really an archaic *Scina*, retaining properties which other members of the family have relinquished. Changes in the mode of defining the new genus will no doubt be required if further examples of the species on which it is founded show a more advanced development, but the mandibles will still distinguish it from all hitherto known Scinidæ *.

4. Archæoscina Bonnieri, n. sp. (Plate 3 A.)

The single specimen from its minuteness and the shape of its first antennæ ran a risk of being laid aside as a young one of some species of *Scina*. The material at hand for comparison was not sufficient to encourage a hope that the question of such relationship could be settled. On the other hand, from two specimens of about the same size, undoubtedly juvenile species of *Scina*, the present form was distinguished by having the back imbricated instead of smooth, by the numerous sensory filaments on the first antennæ, and the needle-like spine on the second. Dissection showed a still more notable difference in regard to the mandibles.

Whether the first and second segments of the peræon were distinct or partially coalesced, and whether any eyes were present or not, could not be made out. The postero-lateral angles of the first three pleon-segments are rounded.

The first antennæ are planted wide apart. Two short, apparently separate, peduncular joints are followed by a thick slowly tapering joint, fringed on the inner margin with eight or more pairs of sensory filaments. To this succeed two small narrow joints followed by a longer transparent joint with two spinules projecting from its blunt apex.

The second antennæ appear to have four peduncular joints, none of them very long, followed by one or two small flagellar joints and at the end the needle-like spine, longer than all the joints of the appendage together and extending beyond the first antennæ.

Mandibles.—The exact shape and armature could not be satisfactorily made out, but in each the palp was uninjured, with second joint longer than the first, and the slightly curved tapering third longer than both the others combined. With the other mouth-organs the dissection was not sufficiently successful to admit of description.

The gnathopods are of the character familiar in the genus *Scina*, the third and fourth joints short, the fourth slightly underriding the fifth, the fifth and sixth subequal in

* "On Vagaries of the Mandibular Palp in the Hyperiidæ." See pp. 34, 35.

length, the sixth (decidedly in the second pair and less certainly in the first) being produced into a point over the base of the slender finger.

The first and second peræopods have the fourth and fifth joints broad, with very convex front margin, the fourth joint about as broad as long. The fingers in all the peræopods are slender, strongly curved at the tips.

The third peræopods are without any conspicuous armature, and have no teeth or serration on either margin of the second joint, the fifth joint is longer than the fourth, and the sixth than the fifth.

The fourth peræopods are shorter than the third, the difference chiefly depending on the sixth joint, which is subequal to the fifth.

The fifth peræopods are very slightly if at all shorter than the fourth on the whole, but have a decidedly shorter fourth joint.

The pleopods have a robust peduncle with a coupling-hook; the rami six-jointed, with a cleft spine on the first joint of the inner ramus.

The first uropods are the longest, with the outer ramus rather less, and the inner considerably more, than twice the length of the peduncle, both rami serrate on each margin. The second uropods are the shortest, with the peduncle barely half the length of the outer ramus, which carries some small spinules on the inner margin and is more than two-thirds the length of the inner ramus. The third uropods have a peduncle nearly as long as that of the first pair, but the inner ramus only as long as the outer of that pair; the outer ramus is four-fifths the length of the inner. The inner rami, as already mentioned in relation to the generic characters, show some indication of being jointed to the peduncle.

Telson apparently oval, very small; so pellucid that its boundaries could not be exactly ascertained.

Length.—From the apex of the first antennæ to the end of the third pleon-segment the specimen measured about one-twentieth of an inch, or 1·25 mm. With the pleon unfolded this would give perhaps a total length to end of uropods of 1·75 mm.

The species is named in compliment to M. Jules Bonnier, whose excellent account of numerous sessile-eyed Crustaceans taken by the 'Caudan' in the Bay of Biscay is well known.

Occurrence: 35 *k*. 400 to 300 fathoms. 1 specimen.

Parascina, n. g.

Near to *Scina*, but differing in the mouth-organs and uropods. First maxillæ with outer plate very broad, its distal border undivided and surmounted with spines and spinules; the palp one-jointed, very broad, distally unarmed. Second maxillæ with inner plate rotundo-quadrate, hirsute, much broader than the somewhat conical and more strongly armed outer plate. Maxillipeds having a pair of broad inner plates, the outer plates almost semicircular, the apices narrowed but not lanceolate. Gnathopods and peræopods with very slender fingers. Third peræopods with second joint not serrate. The uropods all with outer branch well developed, and the inner jointed to the peduncle.

5. Parascina Fowleri, n. sp. (Plate 2 B.)

Front of head straight, inclining to concave, back seemingly rounded, side-plates of peræon small, not angular; first three segments of pleon with postero-lateral angles rounded, fifth and sixth segments coalesced. Eyes protuberant.

First antennæ considerably shorter than the peræon, the peduncle short, two-jointed; first joint of flagellum as in *Scina* long, stout, tapering, bordered with sensory filaments, moderately numerous and slender. To the apex of the long joint succeed two small distinct joints, followed by a short spine-like piece resolvable into two slender joints and a spine.

Second antennæ.—These are of the rudimentary character usual in the female Scinidæ. The first joint is broader than long; the second longer than the first, tapering, rather suggestive of two joints coalesced; the third minute, tipped with a minute setule.

The upper lip was not very exactly determined. It has apparently a small very unsymmetrically placed emargination of the distal border.

The mandibles are long and narrow, widest at the point at which the margin becomes free and slopes to the cutting-edge. This is furnished with a rather large tooth above and a smaller one below. On one mandible there is perhaps a small inner plate, but certainly none on the other, on which, however, the lower tooth seems to be subdivided. The surface of the mandibles is hirsute near the cutting-edge and also in the place of the spine-row. The molar is unrepresented.

The lower lip has two rounded principal lobes, which are feebly hirsute. The mandibular lobes are rather broadly rounded.

First maxillæ.—The inner plate has an even width, with a slight curve, the distal part and broadly rounded apex being strongly hirsute. The outer plate continues the considerable breadth of its base, and carries a group of spinules on the surface proximally, while the free border is fringed round with spinules, to which are added five strong spines on the broad flattened distal margin, and some slighter ones on the outer. The palp at the base is not quite so wide as the outer plate, but presently in superposition outflanks it on both edges and reaches beyond its distal spines, being itself armed only with four to six spinules spaced along its outer margin.

Second maxillæ.—The inner plate is very broad, squarely truncate at the distal margin, which with the straight inner edge is strongly hirsute; the slightly convex outer margin is smooth, except distally, where two larger spines are set among some that are smaller. The surface carries spinules and spines, of which one near the inner distal angle is conspicuous. The outer plate is much narrower, with nearly straight inner and convex outer margin meeting at the apex, both fringed with slender spines, the outer margin carrying distally four of stronger build.

The maxillipeds have two broad inner plates, or possibly a single plate divided into two lobes, both distally hirsute, the distal corner of each (as seen separate and flattened) forming a little sharp point. The outer plates are much larger, smoothly rounded externally till near the apex, where three spines are spaced. The inner margins are adjacent, except at the apex, and are fringed each with eight or nine slight spines.

The first gnathopods have a group of spines at the truncate end of the short fourth joint, the hind margin of the fifth carrying three spines on its proximal half and a group at the apex. The narrower, somewhat tapering, sixth joint has a few spines on each margin, and is produced into a spine-like tooth on each side of the slender finger, which is microscopically hirsute near the middle and has a tiny indent near the apex.

The second gnathopods nearly agree with the first, but are rather longer and more slender, the sixth joint being as long as the fifth, without instead of with the partial help of the distal processes. The branchial vesicle is not much shorter than the second joint.

The first and second peræopods have the fourth joint short but rather broad; the fifth glandular, subequal in length to the narrow tapering sixth, but much broader, both being armed with very slight spinules. The finger is short, slender, little curved.

The third, fourth, and fifth peræopods differ but little one from the other. In all the fourth joint is more than half as long as the fifth, the fifth is subequal in length to the narrowly tapering sixth, and is not much shorter than the second. The finger in all is slender, little curved, and very short. The fifth pair is not quite so long as the two preceding pairs.

The pleopods are of the usual character, carrying a cleft spine on the first joint of the inner ramus, this branch being seven-jointed, while the outer branch has eight joints.

The first uropods have the outer branch more than two-thirds the length of the inner and a very little shorter than the peduncle. The peduncle is serrate on the outer margin, the inner branch pretty strongly and the outer feebly on both edges. The second have the peduncle and inner ramus each a little shorter than in the first pair, but their breadth is rather greater, the armature similar, and the (broken) inner ramus is indicative of a like proportional length. The third pair are the shortest; they have a broad peduncle with smooth margins. The strongly tapering inner ramus is a little longer than the peduncle, faintly serrate on the outer margin; the outer ramus, similar in shape, is less than two-thirds the length of the inner, with its inner margin feebly serrate.

The small oval telson, by its extreme transparency, is obscure in outline.

Length, from apex of first antennæ to extremity of uropods, 8 mm., of which the first antennæ measure about 1·75 mm.

The species is named in well-deserved compliment to Dr. G. Herbert Fowler.

Occurrences: 26 *b*. 2000 to 1500 fathoms. 1 mutilated specimen, 8·75 mm. long.
27 *a*. 1250 to 0 fathoms. 1 specimen.

Scina, Prestandrea, 1833.

Down to the present century this genus by itself constituted the family, and the synonymy can easily be discovered from the references already given in connection with the family designation.

With regard to the subjoined tabular view of existing species, some remarks are requisite. As already noticed, the species *Scina acanthodes* has been transferred to a new genus *Acanthoscina*, of which the mouth-organs are not yet known with any great

exactness. The species *Scina Chuni*, Garbowski, figured and described in that author's very important treatise on the Scinidæ, cannot be distinguished from the earlier *Scina stenopus* published in the Trans. Zool. Soc. London, 1895. *S. longipes* (Dana) remains for the present obscure. As observed by Dr. Garbowski, no weight can be attached to such a character as the angular prominence which Dana depicts and speaks of as representing the medio-frontal margin of the head. Dana regards the fifth and sixth segments of the pleon as separate. In these pellucid animals the ventral dividing-line may easily be mistaken for a dorsal division. *Scina spinosa*, Vosseler, 1901, founded on a female specimen 3·5 mm. long, "perhaps not quite full-grown," should not, I think, be separated from *S. uncipes*, which I founded in 1895 on a male specimen 7·5 mm. long, this being, to judge by the second antennæ, almost completely mature. *Scina Lamperti*, Vosseler, 1901, which, like *S. œdicarpus*, has the second joint of the third peræopods longer than all the rest of the limb, is distinguished by an approach to a subchelate ending of the first and second peræopods. One of these is represented by Vosseler (pl. 9. figs. 3, 3 *a*), but referred to in the 'Tafel-Erklärung' as "Zweites Brustbein," which would indicate the second gnathopod. Other specific names not included in the tabular view are mentioned in the following notes on accepted species.

1.	First antennæ considerably longer than body. 2.	
	First antennæ little or not at all longer than body. 4.	
2.	Prp. 3, second joint longer than following joints combined . .	1. *S. œdicarpus*, Stebbing.
	Prp. 3, second joint not longer than following joints combined. 3.	
3.	First antennæ stout	2. *S. crassicornis* (Fabricius).
	First antennæ slender	3. *S. stenopus*, Stebbing.
4.	First and second gnathopods, apex of sixth joint produced. 5.	
	First and second gnathopods, apex of sixth joint not produced. 6.	
5.	Prp. 5 more than half the length of prp. 4	4. *S. marginata* (Bovallius).
	Prp. 5 much less than half the length of prp. 4	5. *S. incerta*, Chevreux.
6.	Prp. 3, second joint with front margin dentate only at apex. 7.	
	Prp. 3, second joint with front margin dentate not only at apex. 10.	
7.	Prp. 3, second joint with apical tooth bifid	6. *S. pacifica* (Bovallius).
	Prp. 3, second joint with apical tooth simple. 8.	
8.	Prp. 4, fifth joint shorter than fourth or sixth	7. *S. similis*, Stebbing.
	Prp. 4, fifth joint longer than fourth or sixth. 9.	
9.	Telson triangular	8. *S. Tullbergii* (Bovallius).
	Telson truncate	9. *S. concors*, Stebbing.
10.	Prp. 3, second joint with few teeth on front margin	10. *S. Rattrayi*, Stebbing.
	Prp. 3, second joint with many teeth on front margin. 11.	
11.	Prp. 3, second joint longer than following joints combined . .	11. *S. Lamperti*, Vosseler
	Prp. 3, second joint shorter than following joints combined. 12.	
12.	Prp. 3 not longer than prp. 4. 13.	
	Prp. 3 longer than prp. 4. 14.	
13.	Prp. 3 with sixth and seventh joints short	12. *S. Clausii* (Bovallius).
	Prp. 3 with sixth and seventh joints long	13. *S. lepisma* (Chun).
14.	Prp. 5 slender	14. *S. borealis* (Sars).
	Prp. 5 robust	15. *S. uncipes*, Stebbing.

6. Scina crassicornis (J. C. Fabricius).

1775. *Astacus crassicornis*, Fabricius, Systema Entomologiæ, p. 415.
1793. *Astacus crassicornis*, Fabricius, Entomologia Systematica, p. 481.
1793. *Cancer (Gammarellus) crassicornis*, Herbst, Krabben und Krebse, Bd. ii. p. 134.
1830. *Hyperia cornigera*, M.-Edwards, Ann. Sci. Nat. vol. xx. p. 387.
1840. *Tyro cornigera*, M.-Edwards, Hist. Nat. Crust. vol. iii. p. 80.
1853. *Clydonia gracilis*, Dana, U.S. Expl. Exp. vol. xiii. p. 834, pl. 55. fig. 6 *a*, *b*.
1885. *Tyro atlantica*, Bovallius, Bihang t. K. Sv. Vet.-Akad. Handl. Bd. x. No. 14, p. 14.
1885. *Tyro Sarsii*, Bovallius, Bihang t. K. Sv. Vet.-Akad. Handl. Bd. x. No. 14, p. 15.
1887. *Tyro Sarsi*, Bovallius, K. Sv. Vet.-Akad. Handl. Bd. xxi. No. 5, p. 9, pl. 1. figs. 1–17, pl. 2. figs. 1–10.
1887. *Tyro atlantica*, Bovallius, K. Sv. Vet.-Akad. Handl. Bd. xxi. No. 5, p. 13, pl. 2. figs. 11–18.
1888. *Scina cornigera*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1273, pl. 146.
1895. *Scina cornigera*, Stebbing, Trans. Zool. Soc. London, vol. xiii. pt. 10, p. 351.
1896. *Scina Edwardsi*, Garbowski, Denkschr. k. Akad. Wien, Bd. lxiii. p. 103 (67), pl. 1. fig. 2, pl. 3. figs. 19–33, pls. 4–7, pl. 8. figs. 97–109.
1900. *Scina cornigera*, Chevreux, Amphipodes de l'Hirondelle, p. 121.
1901. *Scina Edwardsi*, Vosseler, Die Amphipoden der Plankton-Exp. p. 103.

Additional references might be given, but the above will suffice to explain the synonymy of this species. When describing it as *Scina cornigera* in 1888, I considered that Dana's *Clydonia gracilis* could not be distinguished from it, and with this opinion Dr. Vosseler, the latest writer on the group, agrees. In 1895 I called attention to the probable identity of *Tyro Sarsii*, Bovallius, and this conclusion, which is accepted by my friend M. Ed. Chevreux, was independently arrived at by Dr. Garbowski in 1896. The last-named author, in his elaborate treatise on the Scinidæ, also forcibly argues that *S. atlantica* (Bovallius) is a further synonym. But he thinks it advantageous to discard both the names (*atlantica* and *Sarsii*) given by Bovallius, and to establish in place of them "*Scina Edwardsi*, n. sp." This designation is accepted by Dr. Vosseler, who to "*Scina Edwardsi*, Garbowski," allots no less than five earlier synonyms, since, besides those already mentioned, beginning with the *cornigera* of Milne-Edwards, he includes the *longipes* of Dana. The inclusion of this last must be regarded as extremely hazardous, but all the rest appear to take legitimate precedence of the name *Edwardsi*. There is, however, a name earlier than any of them, which ought not to be neglected. This is the *crassicornis* of J. C. Fabricius, a name probably adopted from the manuscript title of *Cancer crassicornis*, painted by Sydney Parkinson in 1768, of which the drawing, still unpublished, is preserved in the Natural History Museum. Formerly I thought that the description by Fabricius was not sufficiently definite to justify the maintenance of his specific designation, of which the priority was otherwise beyond dispute. Now, however, it appears from the synoptic table of all the known species that there is really only one which adequately satisfies the conditions of the earliest description. There are only three out of the fourteen which have the anterior antennæ longer than the body. But of these *Scina stenopus* has the first antennæ not "*crassiusculæ*," but remarkably slender, and *Scina œdicarpus* is an animal so small that the carination of the back if existent could scarcely have been noticed in the eighteenth

century. Moreover, in both these species there is much less disparity of length between the third and fourth peræopods than that which is indicated by Fabricius. The still obscure and unplaced *Scina longipes* (Dana), with its acutely-produced head-front, does not come into competition with any known form.

A male specimen from Station 31 *b* measured 22 mm. from apex of first antenna to extremity of third uropod; in another the length from front of head to end of uropod was 13 mm., the first antennæ being 8·75 mm. long and the first uropods 3·75 mm.

Occurrences: 33 *a*. 0 fathoms. 1 specimen, ♂.
34 *a*. 25 to 0 fathoms. 2 specimens.
30 *l*. 50 to 0 fathoms. 1 specimen, ♂.
31 *b*. 50 to 0 fathoms. 9 specimens, of which 6 ♂.
34 *c*. 75 to 0 fathoms. 1 specimen.
35 *x*. 100 to 0 fathoms. 1 specimen.

7. Scina œdicarpus, Stebbing.

1895. *Scina œdicarpus*, Stebbing, Trans. Zool. Soc. London, vol. xiii. pt. 10, p. 356, pl. 52 B.

This is an exceedingly transparent little species, and I have not been able to determine whether the thin pellucid integument shows any trace of a medio-dorsal carina. The specific name has not proved very appropriate, since the "swollen carpus" is still more conspicuous in the fifth peræopods of *S. Lamperti*, Vosseler, and elsewhere.

Occurrences: 32 *d*. 100 to 0 fathoms. 1 specimen, ♂ juv.
36 *f*. 150 to 0 fathoms. 2 specimens, 1 ♀, 1 ♂ not fully mature.

8. Scina marginata (Bovallius).

1885. *Tyro marginata*, Bovallius, Bihang t. K. Svenska Vet.-Akad. Handl. Bd. x. No. 14, p. 15.
1887. *Tyro marginata*, Bovallius, K. Sv. Vet.-Akad. Handl. Bd. xxi. No. 5, p. 21, pl. 3. figs. 18–33.
1888. *Scina marginata*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1272.
1889. *Fortunata lepisma*, ♀, Chun, Math. u. Naturw. Mittheilungen Ak. Berlin, Bd. xlv. p. 533 (343), pl. 3. fig. 8.
1889. *Scina lepisma*, Chun, Zoologischer Anzeiger, Jahrg. xii. No. 308, p. 289.
1895. *Scina marginata*, Stebbing, Trans. Zool. Soc. London, vol. xiii. pt. 10, p. 351.
1896. *Scina marginata*, Garbowski, Denkschr. k. Akad. Wien, Bd. lxiii. p. 100 (64), pl. 2, pl. 3. figs. 17, 18.
1900. *Scina marginata*, Chevreux, Amphipodes de l'Hirondelle, p. 122, pl. 14. fig. 8, pl. 15. fig. 1.
1901. *Scina marginata*, Vosseler, Amphipoden der Plankton-Exp. p. 110.

Dr. Garbowski makes *Scina ensicorne*, Prestandrea, 1833, a synonym of this species, without, however, restoring Prestandrea's specific name. But the identification cannot easily be maintained, for whereas Bovallius says of his species, "the body is not carinate," Prestandrea says just as expressly that the body of *S. ensicorne* is dorsally carinate. He further states that the body is 5 lines long and the superior antennæ $3\frac{1}{2}$ lines. This amounts to a total length of more than 17 mm., while of *S. marginata* the total length is given by Bovallius at 6 mm., and Vosseler expresses surprise at finding specimens 8 mm. long. By the sharply-produced anterior apices of the gnathopods

S. marginata is distinguished from all other definitely known species of the genus except *Scina incerta*, Chevreux, and from the latter, in Chevreux's words, "sous tous les autres rapports, elle diffère absolument." Thus in the third peræopods there are teeth along the front margin which are wanting in *S. incerta*; the sixth joint is much shorter than the fourth instead of being equal to it in length; the whole limb is considerably instead of only a little longer than that of the fourth peræopod; and the fifth pair are more than half the length of the fourth, while in *S. incerta* they are only a third of the length of the preceding pair.

Length of single specimen 4·5 mm., the first antennæ representing 1·25 mm. of this measurement.

Occurrence: 35 *p.* 250 to 150 fathoms. 1 specimen.

9. Scina Rattrayi, Stebbing.

1895. *Scina rattrayi*, Stebbing, Trans Zool. Soc. London, vol. xiii. pt. 10, p. 358, pl. 53 A.
1900. *Scina Rattrayi*, Chevreux, Amphipodes de l'Hirondelle, p. 123, pl. 15. fig. 2.
1901. *Scina Bovallii*, Vosseler (not Chun), Amphipoden der Plankton-Exp. p. 105, pl. 9. figs. 8–17.
1901. *Scina Rattrayi*, Lo Bianco, Mittheil. Stat. Neapel, vol. xv. pp. 422, 446.
1903. *Scina Rattrayi*, A. O. Walker, Ann. & Mag. Nat. Hist. ser. 7, vol. xii. pp. 223, 231.

This species was originally described from a single female specimen. Chevreux had at his disposal two male adult specimens, one young male and one female. He describes the second antennæ as observed in the adult males. Vosseler describes an adult male and a young female under the designation "*Scina Bovallii*, Chun." In 1889 Chun applied the name *Fortunata lepisma* to two specimens, which later in the same year he divorced under the separate names of *Scina lepisma* ♀ and *Scina Bovallii* ♂. But if the ruling be accepted that the female which Chun described and figured belongs to the earlier *Scina marginata* (Bovallius), it follows that the name *Scina lepisma* will cling to the male form.

There cannot be any reasonable doubt that Vosseler's *Scina Bovallii* is identical with my *Scina Rattrayi*, which had, unluckily, not come under Dr. Vosseler's notice when he published his valuable treatise on the Hyperiidea of the Plankton Expedition. He recognizes, however, that the identification which he actually adopts without hesitation presupposes several defects in Chun's figure and description of the species. In regard to the third peræopods, Chun states that the fourth joint is shorter than the fifth, also that it is shorter than the sixth, and that the finger is long. But in this limb of *Scina Rattrayi* the finger is minute, and the fourth joint is much longer than all the following joints combined. Chun says that the fourth peræopods are somewhat longer than the third, and Vosseler says the same of the species which he describes; but his figures of these limbs do not support this statement, nor does it apply to Chevreux's figures of *Scina Rattrayi*, nor to the specimens which I have examined. Chun institutes a comparison between his species and *Scina borealis* (Sars) and *Scina Clausi* (Bovallius), pointing out that the differences rest chiefly on the form of the third and fourth peræopods, and on the circumstance that the last-mentioned couple of species have each five pairs of branchial vesicles, whereas in his own species there are only four

pairs, none being present on the second gnathopods. Vosseler does not definitely say that this is the case with the form which he has examined, but implies it by speaking of "the four pairs of branchiæ situated behind the third to the sixth leg," in evident allusion to Chun's mode of expression, "four pairs of branchial sacs between the third to the seventh pair of thoracic feet." In the specimen from the Bay of Biscay, which specimen I dissected with a special view to this point, the second gnathopods are beyond doubt provided with branchial sacs, and this specimen agrees in one respect better with Dr. Vosseler's figure than with my own, for in the fourth peræopods I have represented the sixth joint rather shorter than the fourth, but Vosseler, who describes it as being as long as the fourth, figures it as longer, which it really is in the instance most recently examined. Chun assigns a spine-process to the third joint of the third peræopods, using this as a mark to distinguish his *S. Bovallii* from the *S. Clausi* of Bovallius. But no such spine is found in *S. Rattrayi*. Under all these circumstances it seems unsafe to cancel the latter name in favour of *S. lepisma*, however the differences of description might be conjecturally explained away.

Length of specimen, first antennæ included, 3·3 mm.

Occurrence: 32 *o*. 75 to 0 fathoms. 1 specimen.

10. Scina lepisma (Chun). (Plate 3 B.)

1889. *Fortunata lepisma*, ♂, Chun, Math. u. Naturw. Mittheilungen Ak. Berlin, Bd. xlv. p. 533 (343), pl. 3. fig. 10.

1889. *Scina Bovallii* (and *Bovalli*), Chun, Zool. Anzeiger, Jahrg. xii. No. 309, p. 308.

It was not till after I had completed, as I thought, my present review of this family that an example of Chun's interesting species came to light in a bottle containing some larger Hyperiids. The very close agreement with Chun's description in almost all particulars of moment will be seen from the figures of details here given (Pl. 3 B). The telson, however, is not rounded off, but narrowly triangular, and there are small branchial vesicles to the second gnathopods as well as to the four following pairs of limbs. The mouth-organs are very small, the upper lip very unsymmetrically bilobed, and the twin plates of the maxillipeds are not drawn out into sharp apices. The outer margin of the large joint in the flagellum of the first antennæ shows seven or eight teeth. In the first and second peræopods the fifth joint, which is longer than the fourth or sixth, is conspicuously glandular. In the remarkable third pair the short tooth on the third joint is minute as in various other species, but the shortness of the fourth joint, in comparison with the slender curved hand, and the elongated finger are highly distinctive. In the fourth pair the second joint is in our specimen not quite so long as the fourth and fifth combined, thereby slightly differing from Chun's description.

Length of the specimen, a nearly full-grown male, 4·5 mm. Chun's specimen measured 5 mm. It was a male in the same condition as the present example with regard to the overlapping second antennæ, and was taken at a depth of 1600 m. between Tenerife and Gran Canaria.

Occurrence: 36 *k*. 300 to 0 fathoms. 1 specimen.

11. Scina borealis (Sars).

1882. *Clydonia borealis,* Sars, Christiania Vidensk. Forhandlinger, No. 18, p. 76, pl. 3. fig. 1 *a–b.*
1887. *Tyro borealis,* Bovallius, Bihang t. K. Svenska Vet.-Akad. Handl. Bd. xi. No. 16, p. 4.
1887. *Tyro borealis,* Bovallius, K. Svenska Vet.-Akad. Handl. Bd. xxi. No. 5, p. 16.
1888. *Tyro borealis,* Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 538.
1888. *Scina borealis,* Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1272.
1889. *Scina borealis,* Chun, Zool. Anzeiger, Jahrg. xii. No. 309, p. 309.
1890. *Scina borealis,* Sars, Crustacea of Norway, vol. i. pt. 1, p. 20, pl. 8.
1895. *Scina borealis,* Stebbing, Trans. Zool. Soc. London, vol. xiii. pt. 10, p. 350.
1896. *Scina borealis,* Garbowski, Denkschr. k. Akad. Wien, Bd. lxiii. p. 99 (63).
1901. *Scina borealis,* Vosseler, Amphipoden der Plankton-Exp. p. 103.

A very imperfect specimen apparently referable to this species was obtained at Station 34 *e.* It agrees with the species described and figured by Sars in the characters of the third peræopods, and in the peculiarity of having the second joint of the fourth peræopods produced into a tooth. The first antennæ were missing; without these it measures 6·25 mm.

Another specimen was obtained at Station 27 *a.* It was not in perfect condition, but the first antennæ, third peræopods, and first uropods were in agreement with the characters assigned by Sars.

Occurrences: 27 *a.* 1250 to 0 fathoms. 1 specimen.
34 *e.* 750 to 500 fathoms. 1 specimen.

Scinidæ too young for identification occurred in the following hauls:—

25 *k.* 50 to 0 fathoms.
30 *f.* 75 to 0 ,,
21 *h.* 100 to 0 ,,
36 *g.* 200 to 0 fathoms.
21 *o.* 200 to 100 ,,

Fam. Lanceolidæ.

1840. *Hypérines ordinaires,* M.-Edwards, Hist. Nat. Crust. vol. iii. pp. 74, 77.
1862. *Hyperidæ,* Bate, Brit. Mus. Catal. Amph. pp. 287, 304.
1887. *Lanceolidæ,* Bovallius, Bihang t. K. Svenska Vet.-Akad. Handl. Bd. xi. No. 16, p. 5.
1887. *Lanceolidæ,* Bovallius, K. Svenska Vet.-Akad. Handl. Bd. xxi. No. 5, p. 27.
1888. *Lanceolidæ,* Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1301.
1900. *Lanceolidæ,* Sars, Norwegian North Polar Expedition, Crustacea, p. 14.
1900. *Lanceolidæ,* Chevreux, Amphipodes de l'Hirondelle, p. 134.
1901. *Lanceolidæ,* Vosseler, Amphipoden der Plankton-Exp. p. 127.

The family is still limited to a single genus.

Lanceola, Say, 1818.

This name was reinstated by Bovallius in 1885, after having been long merged in *Hyperia* by Milne-Edwards and others, and in *Vibilia* by Spence Bate. Had it been really identical with either of those genera, it must still have been upheld by reason of its priority over both of them.

Six species were added to the genus by Bovallius in 1885, but of these in 1887 he withdrew *Lanceola curticeps* as a synonym of *L. felina*. Of four species added by myself in 1888, I now propose to withdraw *L. Suhmi* as belonging on a balance of probabilities to the earlier *L. serrata* of Bovallius. This leaves at present nine species to be distinguished in the genus, exclusive of *L. Murrayi*, Norman (see page 30). It is possible that Say's *L. pelagica* may be identical with the *L. Sayana* of Bovallius, since the chief mark of distinction rests on a measurement which, at the date when Say wrote, was not likely to have been made with much exactness. Between the antarctic *L. australis* and the arctic *L. serrata* there is also a rather conspicuous resemblance.

1.	Prp. 5 (said to be) not shorter than prp. 2	1. *L. pelagica*, Say.
	Prp. 5 shorter than prp. 2. 2.	
2.	Prp. 3 not obviously shorter than prp. 4	2. *L. Lovéni*, Bovallius.
	Prp. 3 obviously shorter than prp. 4. 3.	
3.	Rostrum conspicuous. 4.	
	Rostrum not conspicuous. 5.	
4.	Telson as long as peduncle of urp. 3	3. *L. Sayana*, Bovallius.
	Telson much shorter than peduncle of urp. 3	4. *L. felina*, Bovallius.
5.	Prp. 4 shorter than prp. 2	5. *L. Clausii*, Bovallius.
	Prp. 4 longer than prp. 2. 6.	
6.	Pleon with medio-dorsal teeth. 7.	
	Pleon without medio-dorsal teeth. 8.	
7.	Body not carinate	6. *L. serrata*, Bovallius.
	Body medio-dorsally angled	7. *L. australis*, Stebbing.
8.	Telson as long as peduncle of urp. 3	8. *L. pacifica*, Stebbing.
	Telson much shorter than peduncle of urp. 3	9. *L. æstiva*, Stebbing.

12. Lanceola æstiva, Stebbing.

1888. *Lanceola æstiva*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1309, pl. 153.

Two specimens occurred in the collection. The whole integument is pellucid, in delicacy almost like tissue-paper. The front of the head is obtuse, without rostrum, and it is doubtful whether the medio-dorsal line of the body is at any part angled, though a little lateral pressure might easily give a specimen the appearance formerly described of being both rostrate and subcarinate. One of the present specimens, on being dissected, showed otherwise minute agreement with the much larger example described in the 'Challenger' Reports, except that the fifth joint in the second antennæ proved to be rather longer than the fourth instead of scarcely so long, and the spines or spinules on the first gnathopods were less numerous.

Of the species described by Bovallius, both *L. serrata* and *L. Lovéni* are, like *L. æstiva*, hyaline, with the integument very thin and finely reticulated. All the three have the peræopods slender and most of them elongate. The general similarity, indeed, makes it desirable that the distinctive features of each should be carefully noted.

The character of the rostrum is difficult to use. Of *L. serrata* Bovallius says, "the obtuse rostrum is scarcely half as long as the rest of the head"; and of *L. Lovéni*, "the obtuse rostrum is almost as long as the rest of the head." What shape of rostrum is

intended cannot, I think, be gathered from the figures of the head in lateral view. *Lanceola serrata*, however, is sharply distinguished from its two companions by the projecting medio-dorsal teeth of the first four pleon-segments forming a serrate crest, to which the species owes its name, and by the much more elongate telson, which is not much shorter than the peduncle of the third uropods, whereas in the other two it is only a little more or less than half the length of that peduncle. On the other hand, *L. Lovéni* is with equal sharpness separated from the other two species by its first gnathopods, in which the hand or sixth joint is nearly as broad as it is long, much more than half the width of the preceding joint, "very thick, swollen, the anterior margin semicircular," and by the fact that the third and fourth peræopods are almost equal in length. In both limbs alike Bovallius states that the fourth joint is shorter than the sixth. In *L. æstiva*, as in *L. serrata*, the fourth joint is longer than the sixth in the third pair, but shorter than the sixth in the fourth pair.

The length of each specimen, including the first antennæ and uropods, was about 15 mm.

Occurrences: 30 *e*, mesoplankton trawl. 2000 to 1000 fathoms. 1 specimen.
36 *l*. 350 to 0 fathoms. 1 specimen.

13. Lanceola pacifica, Stebbing.

1888. *Lanceola pacifica*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1302, pls. 151, 152.

This species undoubtedly comes very near to *L. Sayana*, Bovallius; but whereas the latter has a pronounced triangular rostrum, and is "distinguished from its allies by the angular prominences of the integument of the sides" of the peræon, the present species has a small obtuse rostrum (as observed in the Pacific specimen) or is quite without one (in the examples from the Bay of Biscay), and is devoid of the lateral angular prominences of the peræon. Here also the back of the peræon is rounded, except for faint traces of an interrupted carina on the first three segments. In *L. Sayana* the keel appears to extend all along the body, as Bovallius writes, "the dorsal line forms an obtuse keel, which is interrupted between the segments." He further states that "the integument is thick, calcareous," epithets which will not apply to the covering of *L. pacifica*.

The length of one specimen, from apex of first antenna to end of third uropod, 12·5 mm.; of the other, the antennæ not included, 13·25 mm.

Occurrences: 32 *n'*. ?100 to 0 fathoms*. 1 specimen (12·5 mm.).
34 *b*. 100 to 0 fathoms. 1 specimen (13·25 mm.).

Lanceola Murrayi, Norman, described and partially figured in the 'Annals and Magazine of Natural History,' ser. 7, vol. v. p. 135, pl. 6. figs. 1–4 (1900), might apparently be united with *Lanceola felina*, Bovallius, but for the difference that the first peræopods have the hand longer, instead of shorter, than the wrist. The amount of this difference cannot be estimated, as there is no detail figure of the limb for either species.

* *Cf.* Dr. G. H. Fowler's "Methods and Data," *suprà*, p. 11.

Fam. Vibiliidæ.

This family is still content with a single genus.

Vibilia, Milne-Edwards, 1830.

The species assigned to this genus are now rather numerous, but the material in the present collection is too small to justify a full discussion. The recent additions are *V. erratica*, Chevreux, 1892; *V. Bovallii*, Bonnier, 1896; *V. hirondellei*, *dentata*, and *grandicornis*, described by Chevreux in 1900; and *V. cultripes* by Vosseler in 1901.

14. Vibilia armata, Bovallius.

1887. *Vibilia armata*, Bovallius, Bihang t. K. Svenska Vet.-Akad. Handl. Bd. xi. No. 16, p. 10.
1887. *Vibilia armata*, Bovallius, K. Svenska Vet.-Akad. Handlingar, Bd. xxi. No. 5, p. 69, pl. 10. figs. 15–22.
1901. *Vibilia armata*, Vosseler, Amphipoden der Plankton-Expedition, p. 125.

This species belongs to a group in which the postero-lateral angles of the sixth pleon-segment are produced backward so as partially to overlap the peduncles of the third uropods. Within that group it is distinguished by the second gnathopods, which have the anterior apex of the sixth joint acutely produced.

The head is very obtusely rostrate. The fifth and sixth segments of the pleon are coalesced. The eyes are large, dark, broader above than below. The first antennæ are rather sharply tapering. The dissected specimen differed from that described by Bovallius in having six spines instead of only three along the convex margin of the hand in the first gnathopods. The eggs numbered about a hundred.

Length, including the first antennæ, about 8·75 mm.

By this capture the known distribution of the species is extended considerably northward.

Occurrence: 31 *b*. 50 to 0 fathoms. 2 specimens.

15. Vibilia propinqua, Stebbing.

1888. *Vibilia propinqua*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1279, pl. 147.
1901. *Vibilia propinqua*, Vosseler, Amphipoden der Plankton-Expedition, p. 124.

The specimen closely agrees with the description given in the 'Challenger' Report, except that the apex of the telson is obliquely truncate, which must be an accidental deformity. Dr. Vosseler, who had several specimens at command, found that the rostrum was variable, being sometimes obsolete even in large specimens. He speaks of it as very near to *V. Jeangerardii*, Lucas, and *V. viatrix*, Bovallius. From the latter of these it is distinguished by having the fifth and sixth segments of the pleon coalesced, and from the former by a very differently shaped telson. In the first gnathopods of *V. propinqua* the sixth joint has no such rounded projecting apex of the hind margin

as Bovallius figures for *Vibilia viatrix*. From another near-standing species, *V. hirondellei*, Chevreux, *V. propinqua* is separated by the much shorter process of the fifth joint in the second gnathopods, this process in Chevreux's species reaching even beyond the hind margin of the following joint.

The total length of the specimen was about 7·5 mm.

The species having been originally taken in the Pacific Ocean, some surprise might have been felt at its occurring in the Bay of Biscay, but in the interval Dr. Vosseler has reported it from the Sargasso Sea, the Guinea current, and the south equatorial current.

Chevreux ('Amphipodes de l'Hirondelle,' p. 125, 1900) has pointed out that the ordinary form of *V. Jeangerardii*, Lucas, has the last joint shorter than the penultimate in the fifth peræopods and the fifth and sixth segments of the pleon only separated laterally, whereas in the form assigned to that species by Bovallius these segments are distinct all across the back, and the finger of the fifth peræopods is stated to be much longer than the preceding joint.

Occurrence: 36 *c*. 25 to 0 fathoms. 1 specimen.

Fam. Phronimidæ.

Phronima, Latreille, 1802.

1802. *Phronima*, Latreille, Hist. Nat. des Crustacés et des Inseetes, vol. iii. p. 38.
1889. *Phronima*, Bovallius, K. Svenska Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 342.
1895. *Phronima*, Chun, Bibliotheca Zoologiea, Heft xix. p. 107.
1900. *Phronima*, Chevreux, Amphipodes de l'Hirondelle, p. 136.
1901. *Phronima*, Vosseler, Amphipoden der Plankton-Exp. p. 1.

16. Phronima sedentaria (Forskål).

1775. *Cancer sedentarius*, Forskål, Deseriptiones Animalium in Itin. Orientali, pp. xxi, 95.
1803. *Phronima sedentaria*, Latreille, Hist. Nat. des Crustaeés et des Inseetes, vol. vi. p. 281.

Latreille, in 1802, gives *Cancer sedentarius* as "exemple" of the genus *Phronima*, but does not actually print the specific name in its feminine form till the following year.

In the present collection there is a small specimen taken at Station 35 *y* between the surface and 75 fathoms, and another taken at 35 *f* between the surface and 100 fathoms, both being apparently young males of this species. This material does not seem to justify a discussion of the controversy which has arisen of late years as to the species in this genus. In the century that has elapsed since the genus was instituted, writer after writer has been tempted to establish new species, each being in general less ready to accept the validity of his predecessor's innovation than to follow his example by making a fresh one. A study of the works referred to above will show the intrinsic difficulties of the subject.

Fam. Hyperiidæ.

1852. *Hyperidæ* (part.), Dana, Amer. Journ. Sci. & Arts, ser. 2, vol. xiv. p. 314.
1886. *Hyperiidæ*, Sars, Norwegian North-Atlantic Exp. vol. xv. Crustacea, pt. ii. p. 36.
1888. *Hyperidæ*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1372.
1889. *Hyperiidæ*, Bovallius, K. Svensk. Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 74.
1890. *Hyperiidæ*, Sars, Crustacea of Norway, vol. i. p. 5.
1900. *Hyperidæ*, Chevreux, Amphipodes de l'Hirondelle, p. 138.
1901. *Hyperiidæ*, Vosseler, Amphipoden der Plankton-Exp. p. 51.

In the later works above cited there will be found a large fund of information respecting this family, to which Dr. Bovallius especially has paid minute attention. The species represented in the present collection are not numerous enough to justify a discussion of the whole group.

Hyperia, Latreille, 1823.

1823. *Hyperia*, Latreille (in Desmarest), Dict. Sci. Nat. vol. xxviii. (Malacostracés).
1901. *Hyperia*, Vosseler, Amphipoden der Plankton-Exp. p. 56.

Between the first and latest writers on this genus there is an immense array, and, as Bovallius explains, the type species was known some sixty years before the genus received its present name.

17. Hyperia luzoni, Stebbing.

1888. *Hyperia luzoni*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1382, pl. 166 A, and "young (?)," p. 1384.
1889. *Hyperia luzoni*, Bovallius, K. Svensk. Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 212.
1901. *Hyperia luzoni*, Vosseler, Amphipoden der Plankton-Exp. p. 64, pl. 5. figs. 16–28.
1901. *Hyperia luzonii*, Lo Bianco, Mittheil. Stat. Neapel, vol. xv. pp. 424, 446.

The original descriptions referred to a single male specimen, 3·75 mm. long, from the China Sea, off Luzon, lat. 16° 35′ N., and a specimen less than 3 mm. long, which, as Vosseler points out, is doubtless a young male, from the South Pacific, lat. 38° 6′ S. Vosseler had at his command 22 specimens, including young males and females and many adult females, showing an extensive range in the Atlantic.

The species is represented in the present collection by a female 2·5 mm. long, which must be regarded as mature, seeing that it contained some four-and-twenty large eggs. In several respects this species resembles that described by Bovallius and by Vosseler as *Hyperia Fabrei* (Milne-Edwards), from which, however, it is distinguished not only by various minute details of armature, but by two tolerably conspicuous features, in that the second joint of the third, fourth, and fifth peræopods is here far less dilated, while the proportion which the telson bears to the peduncle of the last uropods is far greater. The latter distinction is modified, but not cancelled, by Vosseler's observation that in *H. Fabrei* the telson of the female is considerably larger than that of the male. In this latter species, Vosseler gives the extreme length of the animal as 4 mm.; Bovallius gives

the length as varying from 4 to 6 mm. But the original *Lestrigonus Fabrei* of Milne-Edwards is said to be "long d'environ cinq lignes," equivalent to 10·5 mm. From the state of knowledge at the time when Milne-Edwards was writing, it was scarcely to be expected that either his description or figure would contribute much of the detail now required for discriminating species of this genus, but the disparity of size is so great as to make the identification of his form from the Indian Ocean with that since found in the Atlantic, to say the least, highly improbable. I therefore propose to distinguish the *H. Fabrei* of Bovallius by the new name *Hyperia Vosseleri*.

In *H. luzoni*, according to Vosseler, the fifth joint in the first peræopods is armed with a single stiffly outstanding seta, in the second pair with two such setæ, and in each of the three following pairs with one slender seta. My own observation agrees with this account, except that I find two of the setæ or spines on the fifth joint in the first as well as in the second peræopods. They are found also in both first and second peræopods of *H. Vosseleri*. In that species the spine is wanting on the fifth joint of the last three pairs of peræopods. But also in the 'Challenger' specimens of *H. luzoni* this spine was wanting.

Occurrence: 34 *d*. 100 to 0 fathoms. 1 ovigerous ♀.

Hyperioides, Chevreux, 1900.

1900. *Hyperioides*, Chevreux, Amphipodes de l'Hirondelle, p. 143.

1901. *Parahyperia*, Vosseler, Amphipoden der Plankton-Expedition, p. 56 (without definition).

M. Chevreux gives the following definition of the genus:—"Body much more compressed than in the species of the genus *Hyperia*. Head prolonged anteriorly, above the insertion of the upper antennæ. Eyes occupying only the upper part of the head. Palp of the mandibles remarkably long. Basal part of the maxillipeds very elongate; internal lobe little developed. Carpus [fifth joint] of the gnathopods strongly produced in both pairs. Feet of the fifth and sixth pairs [third and fourth peræopods] very long, equal; feet of the seventh pair [fifth peræopods] much shorter. Uropods rather elongate. Telson much broader than long, semicircular."

The definition, as it stands, applies to a single species and in fact to only one sex of that species. Here, as in some other members of the Hyperiidæ, it proves that the female is devoid of a mandibular palp. But there are probably two species already known, which are so closely allied that the generic character must be further modified so as to admit them side by side. Dr. Vosseler, while studying the same form as that which M. Chevreux has named *Hyperioides longipes*, was so struck by its resemblance to the 'Challenger' species *Hyperia sibaginis* that he described it under that name. Unaware at the time of M. Chevreux's recently published generic title, he suggested in his own work the designation *Parahyperia* as suitable for marking the rather fine distinctions by which the new genus is separated from *Hyperia*. Also he suggested that the European form might have to be called *Hyperia sibaginis* var. *longipes* or simply *Hyperia longipes*, thus not insisting on his proposal of a new genus *Parahyperia*, but lighting upon the very same specific name as that already used by M. Chevreux.

But the effect of admitting *Hyperia sibaginis* into the genus *Hyperioides* will be to deprive that genus of one of its most striking characters, "eyes occupying only the upper part of the head." For the figure in the 'Challenger' Report, which has the independent guarantee of Dr. Bovallius, shows the eyes covering the cheeks as usual in *Hyperia*. In *H. longipes* there is always a considerable part of the cheek on which no ocelli are abutting. Unless, therefore, the figure of the Pacific form is erroneous, this disposition of the ocelli will furnish an important specific distinction, but cannot be retained in the definition of the genus.

The front of the head is blunt, so that there is no question of a rostral prolongation in advance of the first antennæ, and the projection apparent in lateral view is almost confined to the male, the head in the female being on the whole strongly truncate in front, presenting, as Dr. Vosseler says, "in lateral view a form quite unusual for a species of *Hyperia*, that of a genuine *tête carrée*."

18. Hyperioides longipes, Chevreux.

1900. *Hyperioides longipes*, Chevreux, Amphipodes de l'Hirondelle, p. 143, pl. 17. fig. 2.
1901. *Hyperioides longipes*, Lo Bianco, Mittheil. Stat. Neapel, vol. xv. pp. 422, 447.
1901. *Hyperia sibaginis*, Vosseler, Amphipoden der Plankton-Expedition, p. 60, pl. 7. figs. 6–20 (*Parahyperia*?, p. 56, *Hyperia sibaginis* var. *longipes*, or *Hyperia longipes*, p. 63).
1903. *Hyperioides longipes*, A. O. Walker, Ann. & Mag. Nat. Hist. ser. 7, xii. p. 229, pl. 19. figs. 7–13.

Excellent figures and descriptions of the species have been given by M. Chevreux, Dr. Vosseler, and Mr. A. O. Walker, F.L.S. The only addition of importance to insist on is the circumstance already noted that in the female the mandible is without a palp. Dr. Vosseler, in describing the female, speaks of the mandibles as having a three-jointed palp, but he gives references to figures of the mandible which in the explanation of his plate are attributed to a male. It may be inferred, therefore, that identity of the mouth-organs in the two sexes was presumed by him, as it had been by M. Chevreux in defining the genus. Claus, in 'Die Platysceliden,' p. 3 (1887), contrasting "die Hyperinen" with "die Gammarinen," says boldly of the former that "the mandible carries a three-jointed palp only in the male sex." In response to this, Dr. Bovallius (Mon. Amph. Hyperiidea, p. 158, 1889) declares that in the female of *Hyperia medusarum* (O. F. Müller), called *H. spinipes* by Boeck, the mandibles are exactly like those in the male, but a little more robust, and he gives a drawing of these organs in the female of this typical species on purpose to show the three-jointed palp. This palp is present likewise in the female of *Hyperia galba* (Montagu). On the other hand, in the three 'Challenger' species *Hyperia luzoni*, *H. dysschistus**, and *H. schizogeneios*, the females show no mandibular palp, and this is the case also in the two species recently described by Dr. Vosseler as *H. macrophthalma* and *H. hydrocephala*. The last-named author suggests that such species should be grouped in a subgenus. He has further observed that in *H. Fabrei*, Milne-Edwards, the mandibles of the female are variable, sometimes having no palp and at others one that is small and uniarticulate.

* A. O. Walker now identifies this with *Hyperia bengalensis* (Giles), in 'Report on the Amphipoda collected by Professor Herdman at Ceylon,' p. 235 (1904).

There still remain some species of *Hyperia* in which the mandibles have been definitely described for the male only, so that a subdivision of the genus dependent on the mandibular character in the two sexes cannot for the moment be completely carried out.

It should be borne in mind that in *Hyperioides longipes*, though the fifth joint is produced in both pairs of gnathopods, it is less so in the first than in the second. The elongate third and fourth peræopods have the fourth joint shorter than the fifth, but in the shorter fifth pair the fifth joint is a little shorter than the fourth. The third uropods have a striking appearance by reason of the deep denticulate emargination at the upper part of the inner border in the outer ramus, which is rather longer than the inner one. This character becomes more conspicuous in proportion to the size of the specimen. The almost semicircular telson can scarcely be relied on as furnishing a permanent generic character, since *Hyperia Fabrei*, Milne-Edwards, has a completely similar telson, while other species of the genus have the telson triangular.

The length of measured specimens varied from 2·5 mm. to a little over 5 mm., none attaining the length of 6 mm. assigned by Chevreux and Vosseler to full-grown males.

This species was obtained in the Bay of Biscay in no less than thirty-two hauls. There were several males with numerously-jointed antennæ, but none in which the flagellar joints had attained the elongate tenuity characteristic of complete development. The great majority of the specimens were obtained by hauls between the surface and 100 fathoms. The occurrences are discussed on p. 49.

Parathemisto, Boeck, 1871.

1871. *Parathemisto*, Boeck, Vid.-Selsk. Forhandlinger (Christiania) for 1870, p. 87 (7).
1889. *Parathemisto*, Bovallius, K. Svensk. Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 248.
1890. *Parathemisto*, Sars, Crustacea of Norway, vol. i. p. 10.
1901. *Parathemisto*, Vosseler, Amphipoden der Plankton-Exp. p. 80.

The dilated and more or less ovoid fifth joint of the first and second peræopods, by which in adults the species of this genus and of *Euthemisto* are so readily distinguished from *Hyperia*, does not attain its characteristic shape in very young specimens.

19. Parathemisto oblivia (Kröyer).

1838. *Hyperia oblivia*, Kröyer, Grönlands Amfipoder, Danske Selsk. Afh. pt. vii. p. 298, pl. 4. fig. 19.
1871. *Parathemisto abyssorum*, Boeck, Vid.-Selsk. Forhandlinger (Christiania) for 1870, p. 87 (7).
1889. *Parathemisto oblivia*, Bovallius, K. Svenska Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 251, pl. 12. figs. 11–16, and figures in text.
1896. *Parathemisto oblivia*, Bonnier, Ann. Univ. Lyon, Campagne du 'Caudan,' p. 611, pl. 35. fig. 1.
1898. *Parathemisto abyssorum*, Fowler, Proc. Zool. Soc. London, p. 583.
1901. *Parathemisto oblivia* (?), Vosseler, Amphipoden der Plaukton-Exp. p. 80, pl. 7. figs. 21–25, pl. 8. figs. 1, 2.

Without giving all the references, it may suffice here to say that the identification of Boeck's *P. abyssorum* with Kröyer's species was suggested as probable by H. J. Hansen in 1887, accepted by Bovallius in 1889, Sars in 1890, and Chevreux in 1900. The

variations in size are perplexing, M. Bonnier recording an ovigerous female 10 mm. in length from a depth of 950 metres in the Bay of Biscay, while Sars speaks of North Atlantic specimens 17 mm. long, and others wholly agreeing with these except in being taken at much less depths and in scarcely exceeding a length of 5 mm. Dr. G. H. Fowler mentions specimens from Valentia, Galley Head, and the Firth of Forth, the curious fact about which is "that they are all very small, ranging from 2 to 5 mm.; whereas in the Faeroe Channel they are mostly about 7–10 mm. in length." Bovallius gives the length as 5–8 mm.

Boeck makes a dorsal carina characteristic of the genus, and Bovallius describes the body in this species as feebly carinated, less distinctly in the female than in the male. This account would not be inconsistent with a disappearance of the carina from very small or young specimens. Vosseler says of the young specimens which he had examined that none had any indication of a dorsal carina, nor could I detect any such indication in specimens of the present collection. Only one of these approached the length of 4 mm.

Very small specimens, apparently belonging to this genus and perhaps to this species, have the first and second peræopods even more like those of *Hyperia luzoni* than shown in Vosseler's plate 8. fig. 1, representing the first peræopod of a young female "*Parathemisto oblivia*?" Since, however, there are other very small species of *Parathemisto*, it may be doubted whether the younger forms, measuring from 1 to 2 or 3 mm. in length, can be with any certainty discriminated. A careful study of adults and young taken together may in future supply marks of distinction for the young of the several species, but the little isolated specimens of the present collection do not furnish materials for such a study. Yet a specimen only 3·5 mm. long, with articulation in the flagella of the antennæ becoming visible and thus indicating an approach to maturity of the male sex, closely agrees with the figures of *P. oblivia* given by Bovallius and Sars, in regard to the telson and uropods agreeing with Sars rather than Bovallius. In the third peræopods the fifth joint is rather longer than in the fourth pair, and there rather longer than in the fifth. Bovallius speaks of all these limbs as equal in length; but Sars qualifies them as subequal.

The specimen just referred to was taken at Station 21, at the surface. A specimen of the same size, with antennæ doubtful, was obtained at Station 21 *m*, between 500 and 400 fathoms. A smaller male occurred at Station 21 *n*, between 150 and 100 fathoms. A specimen occurred at Station 21 *o*, between 200 and 100 fathoms. Others, for the most part smaller than those mentioned, were taken in various hauls between the surface and depths ranging to 100 fathoms. The largest specimen in the collection, measuring 3·75 mm., was taken at Station 22 *e*, at the surface.

Euthemisto, Bovallius, 1887.

1889. *Euthemisto*, Bovallius, K. Svensk. Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 275.

Guérin's *Themisto*, 1825, being preoccupied, was changed to *Euthemisto* by Bovallius in 1887.

20. Euthemisto compressa (Goës).

1866. *Themisto compressa*, Goës, Öfversigt K. Vet.-Akad. Förhandl. (Stockholm) for 1865, p. 533 (17), pl. 41. figs. 34, 34″.

1889. *Euthemisto compressa*, Bovallius, K. Svenska Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 305, pl. 12. figs. 45–57, pl. 13. figs. 32–43.

1890. *Euthemisto compressa*, Sars, Crustacea of Norway, vol. i. p. 12, pl. 5. fig. 2.

1900. *Euthemisto compressa*, Chevreux, Amphipodes de l'Hirondelle, p. 146.

1901. *Euthemisto compressa*, Vosseler, Amphipoden der Plankton-Exp. p. 81, pl. 8. figs. 11–17.

Bovallius makes *Themisto bispinosa*, Boeck, a synonym of this species, while Sars, Chevreux, and Vosseler keep them apart. It should be noted that in Vosseler's 'Tafel-Erklärung' the numbering of the figures of these two species is transposed. Sars in 1895 (*op. cit.* appendix, p. 673) identifies *Euthemisto bispinosa* with *Themisto crassicornis*, Kröyer. The present collection contains only part of a specimen, ending with the third pleon-segment, a female, measuring from the front of the head to end of fragment 7 mm. It appears to be sharply carinate along peræon and pleon, but devoid of projecting dorsal teeth. It has the character of the first three pairs of peræopods which the figures of Sars and Vosseler show to be distinctive of *E. compressa* from *E. bispinosa*.

Occurrence: 32 *d.* 100 to 0 fathoms. 1 specimen.

Fam. Phrosinidæ.

Primno, Guérin, 1836.

1836. *Primno*, Guérin, Magasin de Zoologie, vol. vi. Classe 7, p. 2.

1887. *Primno*, Bovallius, Bihang till K. Svenska Vet.-Akad. Handlingar, Bd. xi. No. 16, p. 28.

1888. *Primno*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. pp. 164, 1440.

1889. *Euprimno*, Bovallius, K. Svenska Vet.-Akad. Handlingar, Bd. xxii. No. 7, p. 397.

1900. *Euprimno*, Chevreux, Amphipodes de l'Hirondelle, p. 148.

1901. *Euprimno*, Vosseler, Amphipoden der Plankton-Expedition, p. 87.

Bovallius substituted *Euprimno* for the name given by Guérin, "because *Primno* was previously applied to a genus of Crustacea by Rafinesque-Schmaltz in 1814." It is true that the eccentric author referred to, in his 'Précis de ses découvertes,' at the date named, mentioned along with several others a species *Primno lutescens* included in his "Fam. Aselotia and Oniscia." But he did not define the genus. He did not figure or describe the species. He did not even say to which of the two indeterminate families the genus belonged. It is evident, therefore, that Rafinesque's *Primno* is of no scientific importance, and has no claim to supersede the legitimate use of the name by Guérin.

21. Primno macropa, Guérin.

1836. *Primno macropa*, Guérin, Magasin de Zoologie, vol. vi. Classe 7, p. 4, pl. 17. fig. 1 *a–f*.

1888. *Primno macropa*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1441, pl. 178.

1889. *Euprimno macropus*, Bovallius, K. Svenska Vet.-Akad. Handlingar, p. 400, pl. 17. figs. 23–40, pl. 18. figs. 1, 2.

1900. *Euprimno macropus*, Chevreux, Amphipodes de l'Hirondelle, p. 148.

1901. *Euprimno macropus*, Vosseler, Amphipoden der Plankton-Expedition, p. 87, pl. 8. fig. 21.
1901. *Euprimno macropus*, Lo Bianco, Mittheil. Stat. Neapel, vol. xv. pp. 422, 447.

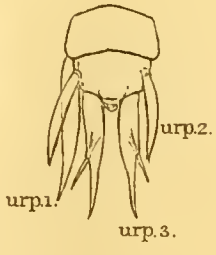
That *macropus* is a more scholarly form than *macropa* must be admitted, but the practice of polishing and improving the names which our scientific ancestors invented has to my mind the same effect as daylight upon Melrose Abbey, where the rays of the sun "gild but to flout the ruins grey."

Bovallius, referring to the species *Primno Latreillei*, *Menevillei*, and *antarctica*, established in the 'Challenger' Report, goes on to say, "After a careful examination of the material at my disposal I am convinced that these three new species are at most varieties of the type species, because the chief differences recorded by Stebbing are liable to great variation, purely individual as well as owing to the age of the animals." Vosseler alludes to and apparently accepts this opinion, though without including the names in the synonymy of the type species. It is, at any rate, a very convenient view to adopt in dealing with the small specimens contained in the present collection with 3 mm. for the upper limit of length.

A specimen measuring about 1·4 mm. was obtained between 50 fathoms and the surface at Station 25 *e*, this being obviously a very juvenile form. Its want of a mandibular palp is unimportant, since this deficiency is a permanent character in the female. Some observations, however, may be offered as to the limbs of the peræon. The gnathopods have practically the adult form, but the first and second peræopods differ from those of the full-grown animal by having the fifth joint much broader than the sixth, its hind margin ending in a strong apical tooth, while the rest of its armature is limited to a minute spinule. The third peræopods, as shown in the figure (text-fig. 1), have the front margin of the broad fifth joint furnished only with three large teeth, the

Fig. 1.

Fig. 2.



intermediate small ones being wholly absent. Both limbs agreed in their armature, a symmetry which Dr. Bovallius found to occur only once in fifteen specimens which he examined of various sizes from 1·5 to 12 mm. in length. The fourth peræopods have the front margin of the fifth joint armed only with an apical tooth. The fifth pair are very small and peculiar. The second joint is straight, narrow, slightly tapering to the distal end, and longer than all the remainder of the limb. This consists of a short third joint followed by a blade-like narrowly ovoid but distally pointed piece, which may be taken to represent the last four joints in one.

The pleopods at this stage have three-jointed rami.

The uropods are of special interest. After discussing the variations in the third peræopods, Dr. Bovallius observes, "In the form and serration of the uropoda there is a similar variation, but more connected with the age of the animal, so that the older animals which have attained a length of 10 or 12 mm. have the uropoda comparatively much broader than in the young, less distinctly serrated, and hardly emarginated at the apex, while the young have the first and second pairs very narrow, sharp-pointed, and finely serrated, and the third pair only a little dilated, sharp-pointed, and deeply emarginate."

In the specimen here described, which is a very little shorter than the smallest of those examined by Bovallius, a completely new relation comes into view. All the uropods are, as Bovallius says, and as the figure (text-fig. 2, p. 39) depicts, sharp-pointed, but there is no perceptible serration and no emargination. The first pair is slightly the longest, though not reaching so far back as the third. The second is considerably shorter and slightly narrower than the other two, and has some way above the middle of the outer margin a minute spinule. The third pair have a slender spine-like outer ramus, proved to be a ramus and not a spine by the muscles attached to it. The place of insertion of this ramus shows that the peduncular part of the uropod is slightly longer than the completely coalesced inner ramus, which is much broader than the outer but not fully twice as long. In the adult there appears to be no reminiscence of this outer ramus, unless the almost terminal emargination of the broad plate into which the uropod eventually develops indicates the place of insertion. Anyone observing the uropods and telson of this young *Primno* on the hinder part of the pleon detached from the rest of its body might well be excused for determining them as belonging to one of the Scinidæ.

Occurrences:	25 *e*.	50 to 0 fathoms.	1 specimen,	about 1·4 mm. long.
	31 *b*.	„ „ „	1 „	2·5 mm. long.
	32 *h*.	„ „ „	1 „	3 mm. long.
	32 *m*.	75 to 0 fathoms.	1 „	young.
	30 *h*.	100 to 0 fathoms.	1 „	3 mm. long.

Fam. Typhidæ.

Brachyscelus, Bate, 1861.

1861. *Brachyscelus*, Bate, Ann. & Mag. Nat. Hist. ser. 3, vol. viii. p. 7.
1888. *Brachyscelus*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1543.

22. Brachyscelus mediterraneus (Claus), 1887.

1887. *Thamyris mediterranea*, Claus, Die Platysceliden, p. 60, pl. 16. figs. 11–18.
1888. *Brachyscelus mediterranea*, Stebbing, 'Challenger' Amphipoda, Reports, vol. xxix. p. 1556.
1900. *Brachyscelus mediterraneus*, Chevreux, Amphipodes de l'Hirondelle, p. 154.
1900. *Brachyscelus crustulum*, Norman, Ann. & Mag. Nat. Hist. ser. 7, vol. v. p. 134.
1903. *Brachyscelus mediterraneus*, A. O. Walker, Ann. & Mag. Nat. Hist. ser. 7, vol. xii. p. 231.

A single specimen, 4·5 mm. long, agrees well with the figure assigned by Claus to

this species, except that in the fifth peræopods the fifth joint is not shorter but longer than the sixth. It does not help to decide the question, which Claus himself leaves doubtful, as to whether his *mediterraneus* should be regarded as a synonym of his earlier-named *globiceps*. Norman may very well be right in considering it to be the young of *B. crusculum*, Bate.

Occurrence: 31 *b*. 50 to 0 fathoms. 1 specimen.

23. Brachyscelus sp.

The collection contains a representative of this genus only 2 mm. in length. The branches of the pleopods are four-jointed and the mouth-organs extremely delicate. It is much smaller than any species hitherto described, and, though all the limbs are well developed, the probability remains that it may be a young form of a species already named—such, for example, as *B. globiceps* or *B. mediterraneus* (Claus). The third peræopods have the second joint elongate-oval, with two spinules on the front margin, which is decidedly convex. The second joint is much more broadly oval in the fourth pair, and less narrowed below than in many species; the fifth and sixth joints have the usual serration of the front margin. The fifth peræopods have the second joint like that in the 'Challenger' species, *B. Bovallii*, long and narrow, much wider above than below. Here, however, the remaining joints are differently proportioned, increasing in length from the third to the sixth, these with the minute finger together about equalling the length of the second joint. The telson is broad, apically subacute, not reaching so far back as the outer branch of the third uropods, which is considerably shorter than the inner branch. A rather larger specimen and one only about 1 mm. long were also obtained.

Supposing these forms to be juvenile, it should be noticed that there is no reminiscence of the strange character described by Bate for the fourth peræopods of the larval *B. crusculum*.

Occurrences: 24 *g*. 0 fathoms. 1 specimen, 1 mm. long.
21 *e*. 0 fathoms. 1 specimen, 2 mm. long.
33 *d*. 100 to 0 fathoms. 1 specimen, 2·5 mm. long.

ENTOMOSTRACA.—Section Branchiopoda.

CLADOCERA.

Tribe ONYCHOPODA.

Fam. Polyphemidæ.

Evadne, Lovén, 1836.

1836. *Evadne*, Lovén, K. Vet.-Akad. Handlingar (Stockholm) for 1835, p. 1.
1902. *Evadne*, Sars, On the Polyphemidæ of the Caspian Sea, Ann. Mus. Zool. Acad. Imp. Sci. St.-Pétersbourg, vol. vii. p. 10 (extract).

The earliest and one of the latest references to this well-known genus will suffice for the present purpose. Sars remarks that it is very abundantly represented in the Caspian Sea, "whereas in the Oceans hitherto only three very sharply defined species

are known, viz., *E. nordmani* Lovén, *E. spinifera* Müller, and *E. tergestina* Claus." Of the last he has convinced himself "that it is very distinct from the other two marine species, being especially distinguished by the fact, that the exopodite of the 2 middle pairs of legs carries 3 well-developed setæ, a character not found in any other known *Evadne*." Thus these three species in their chronological order offer a synoptic arrangement easy to remember:—

Exopod of the third pair of legs.	with one seta	1. *E. Nordmanni*, Lovén.
	with two setæ	2. *E. spinifera*, P. E. Müller.
	with three setæ	3. *E. tergestina*, Claus.

1. Evadne Nordmanni, Lovén.

1836. *Evadne Nordmanni*, Lovén, K. Vet.-Akad. Handlingar (Stockholm) for 1835, pp. 1–29, pl. 1.
1850. *Evadne Nordmanni*, Baird, British Entomostraca, Ray Soc. p. 114, pl. 17. fig. 2.
1901. *Evadne Nordmanni*, Lilljeborg, Cladocera Sueciæ, in Nov. Act. Sc. Upsal. ser. 3, xix. p. 641, pl. 86. ff. 4–17.

This species was taken by the 'Research' at thirty-seven Stations, the depth being specified in eight cases as 0 fathoms, and in most others as between 0 and various depths down to 100 fathoms, but it is also recorded at Station 34 *e* from between 750 and 500 fathoms, one specimen, and at Station 31 *d*, from between 1000 and 750 fathoms, one specimen. There were about 170 specimens in all, the majority coming from nine or ten of the Stations, at which the number ranged from five individuals up to (in one instance) some dozens. These occurrences are discussed on p. 52.

2. Evadne spinifera, P. E. Müller.

1867. *Evadne spinifera*, P. E. Müller, Danmarks Cladocera, Naturhistorisk Tidsskrift, ser. 3, vol. v. p. 225, pl. 6. figs. 11–13.

The long spine at the distal apex of the organism, to which the specific name refers, is an additional and very obvious character for distinguishing this from the preceding species, in which the apical spine is minute and sometimes evanescent. The two species may occur together, Müller's being apparently much the rarer of the two.

At Station 30 *m*, between the surface and 25 fathoms, two specimens were taken, along with several of *E. Nordmanni*. At Station 31 *b*, between the surface and 50 fathoms, several specimens were taken of *E. spinifera* alone.

Occurrences: 30 *m*. 25 to 0 fathoms. 2 specimens, with *E. Nordmanni*.
31 *b*. 50 to 0 fathoms. Several, no *E. Nordmanni*.

THYROSTRACA.

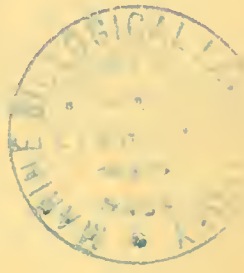
Fam. Lepadidæ.

Cypris-stage of Lepas pectinata, Spengler.

1793. *Lepas pectinata*, Spengler, Skrifter Naturhist. Selskabet, vol. ii. Heft ii. p. 106, pl. 10. fig. 2.
1854. *Lepas pectinata*, Darwin, Balanidæ (Ray Society), pp. 112–114.
1876. *Lepas pectinata*, Claus, Untersuchungen genecal. Grundlage des Crustaceen-Systems, pp. 84, 87, pl. 16. fig. 4.

1883. *Lepas pectinata,* Hoek, 'Challenger' Cirripedia, Reports, vol. viii. p. 40.
1891. *Lepas pectinata,* Gruvel, Contr. à l'étude des Cirrhipèdes, p. 114, pl. 28.
1899. *Lepas pectinata,* Hansen, Die Cladoceren und Cirripedien des Plankton-Expedition, p. 33.

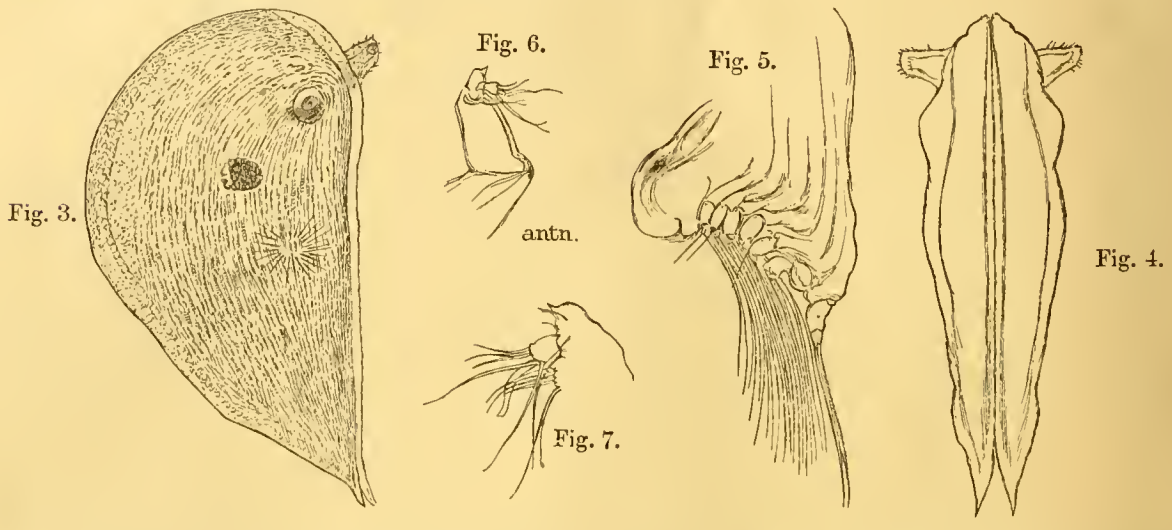
Darwin states that he had examined the pupa of *Lepas pectinata*, and found the surface of the carapace "marked with curious points of various shapes, often star-shaped, in parts reticulated, and confluent along the dorsal margin, and in parts lined." Under the heading "*Acoustic Organs*," he says, "these lead, as described in my former volume, into a sack, with a bag suspended in it, which is provided with a large nerve, and which I believe to be the acoustic vesicle. These orifices occur in the carapace, either in the same position or a little more posteriorly, in the pupæ of all Cirripedes. In *Balanus balanoides* they are minute, being only $\frac{2}{6000}$th [of an inch] in diameter, but are surrounded with a border: in *Conchoderma virgata* they are also surrounded by a border: in *Lepas pectinata* the orifices are $\frac{3}{6000}$th of an inch in diameter, and are very singular from being seated on rounded prominences, causing the carapace to have two short, blunt horns in front." Influenced by the known position of acoustic apparatus in the higher Crustacea, Darwin supposed that these orifices might represent the otherwise missing anterior antennæ in the pupal Cirripede.



On the other hand, M. A. Gruvel, in discussing the *Cypris*-larva of *L. pectinata* says that "its valves carry at the lower part a sort of strong horn, corresponding to what will be the adductor muscle of the valves in the adult" (*loc. cit.* p. 115). He maintains for the Thyrostracan group at large that "hearing has no special organs, since this sense does not exist in the Cirripedes." He bases his conclusion on experiments that seem fairly conclusive for the adult stage, but he does not claim to have observed the effects of them upon larval forms, which would indeed be a matter of considerable difficulty (pp. 55, 179). M. Gruvel gives highly magnified figures of the valve-markings in the *Cypris* of *L. pectinata*, of which he says that, roughly speaking, the ornamentation of the transparent carapace is formed of regularly arranged polygonal thickenings of the chitin, the hexagons or pentagons being marked off by narrow chitinous ribs. This reads like a very different account from Darwin's. But Darwin accurately describes the appearance under a low magnification, whereas every successive enlargement changes the pattern, but on the whole produces the impression of more and more uniformity, as the details in different parts of the valve are more clearly made out.

The single specimen of this *Cypris*-larva in the present collection measured 1·25 mm., or a twentieth of an inch. When the valves were opened the organs within were no longer soft, but dry and unyielding. In lateral view, as shown in fig. 3, p. 44, the shape of the carapace is rather striking, from the great height of the rounded upper half, in contrast with the triangular distal portion, which narrows rapidly to the acute apices. The greatest height is rather more than half the length. About a third of the length from the front, and a little nearer the ventral than the dorsal margin, the dark compound eyes are situated. The ventral margins are for the most part straight and nearly parallel, but not accurately adjusted one to the other, indicating a want of symmetry between the valves, as noted by H. J. Hansen (*loc. cit.* p. 33) for what he supposes to be the pupa of

Lepas anserifera, Linn. The sturdy, slightly hirsute horns, so distinctive of this larva, project from near the front and the ventral margin. In dorsal view, as shown in the diagram (fig. 4), they stand out like a pair of ears at right angles to the carapace. The length of the shell is three and a half times its greatest width or thickness, as measured a little to the rear of the horns, but not quite three times such width if measured along a line including the horns. The dorsal margins diverge only a little in front, but for about a seventh of the total length distally. In the middle of the length, but near the ventral margins, the round radiated scars of the adductor muscle can, with proper focussing, be seen through the honeycomb markings of the valves. The appearance of the limbs and small pleon is indicated in the adjoining figure (fig. 5).



As it were plastered against the inside of the valves below the eyes are the long glands described by Claus as shell-glands, agreeing in structure with that which he figures for the *Cypris*-larva of *Lepas australis* (*loc. cit.* pl. 16. fig. 2, SD.). In the present form they are rather more sinuous in shape. The antennæ here represented (fig. 6), allowing for the fact that they are still free, agree very nearly with Darwin's figure (*loc. cit.* pl. 30. fig. 8) of the antennæ in the attached *Cypris* of *Lepas australis*. The terminal joint, as shown more highly magnified in fig. 7, has three short and two long setæ, and, in addition, a narrow, excessively transparent ribbon, answering to that which Darwin discusses (*loc. cit.* p. 118), and believes "to be a tube of cement-tissue, which thus, sometimes even before the pupa is attached, independently grows outwards."

So far as I can discover, none of the authors who have examined this larval form have supplied a figure of its external appearance, which is sufficiently singular to have a good claim to such a compliment.

The place of capture was Station 32 *a*, between 50 fathoms and the surface.

The figures of the carapace in lateral and dorsal view were drawn with the help of a 1-inch objective, those of the antenna and limbs with $\frac{1}{2}$-inch, and the distal part of the antenna with a $\frac{1}{4}$-inch.

EXPLANATION OF THE PLATES.

Plate 2 A.

Eusirogenes dolichocarpus, n. g. et. sp.

n.s. Natural size indicated by a line showing the length of the specimen enlarged below.
a.s., *a.i.* Upper antenna and part of lower antenna.
l.s. Upper lip.
m.m. Mandibles.
mx. 1, *mx.* 2, *mxp.* First and second maxillæ and maxillipeds.
gn. 1, *gn.* 2, *prp.* 1, 2, 5. First and second gnathopods and parts of first, second, and fifth peræopods.
urp. 1, *urp.* 2. First and second uropods.

In the detail figures the antennæ and appendages of the peræon and pleon are drawn to one scale, portions of *a.s.* and *gn.* 1 being added on the same scale as the mouth-organs. Parts of the mandibles are still more highly magnified.

Plate 2 B.

Parascina Fowleri, n. g. et sp.

n.s. Line showing length of specimen enlarged above.
a.s., *a.i.* Upper and lower antennæ.
m.m., *mx.* 1, *mx.* 2, *mxp.* Mandibles, first and second maxillæ, and maxillipeds.
gn. 1, *gn.* 2, *prp.* 2, 3, 4, 5. First and second gnathopods, second, third, fourth, and fifth peræopods.
urp. 1, *urp.* 2, *urp.* 3, *T.* First, second, and third uropods and telson.

Details of peræon and pleon magnified to a uniform scale; parts of the two gnathopods more highly magnified; parts of other appendages still more highly, in agreement with figures of the mouth-organs.

Plate 3 A.

Archæoscina Bonnieri, n. g. et. sp.

n.s. Line indicating natural size of specimen figured below.
a.s., *a.i.* Upper and lower antennæ.
m.m. Mandibles.
gn. 1, *gn.* 2, *prp.* 1–5. First and second gnathopods, first to fifth peræopods.
plp., *urp.* 1, 2, 3. A pleopod and first, second, and third uropods, the telson appearing between the bases of the third uropods.

All details drawn to the same sale.

Plate 3 B.

Scina lepisma (Chun).

n s. Line showing length of specimen figured to the left.
a.s., *a.i.* Upper and lower antennæ.
l.s., *m.m.*, *mx.* 1, *mxp.* Upper lip, mandibles, first maxilla, and maxillipeds.
gn. 1, *gn.* 2, *prp.* 1–5. First and second gnathopods, first to fifth peræopods.
urp. 1, 2, 3, *T.* First, second, and third uropods and telson.

Details drawn to the same scale.

APPENDIX ON THE DISTRIBUTION OF THE AMPHIPODA AND CLADOCERA.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S., F.Z.S.*

I. THE AMPHIPODA.

When the species captured during the cruise are arranged by hauls, the first thing noticeable is the *comparative rarity* of the Amphipoda. They occurred in only 68 (57 per cent.) of the 118 * "comparable hauls," and were seldom reckoned by more than one or two specimens per haul.

The various species apparently *do not herd together* in the way that some organisms (*e. g.* Chætognatha) often do; for of these 68 hauls, only one included four species, one three species, thirteen two species, and no less than fifty-three (77 p. c.) produced but a single species.

In the 68 hauls were 22 species (*Eusirogenes dolichocarpus* coming from a "non-comparable" haul); of these, no less than twelve (54 p. c.) occurred in one haul only, five (22·7 p. c.) in two hauls, one (4·5 p. c.) in three hauls, two (9 p. c.) in five hauls, and only two species, both evidently common, occurred in more than five hauls. Thus, while there are a considerable number of species, the *number of individuals is small*, except in the two cases mentioned (*Hyperioides longipes* and *Parathemisto ? oblivia*).

It is probably due to the fact that Amphipoda are comparatively scarce in these waters that no single species shows any sign of a diurnal vertical oscillation, such as is generally stated to affect the epiplankton, but which, so far as I am aware, has never been definitely demonstrated. I have al o plotted the whole captures of Amphipoda Hyperiidea on to the time-depth tables (*cf.* pp. 53, 54), but even then can see no certain indication of a nocturnal rise.

As to the distribution of the individual species recorded elsewhere (even when specialists are agreed upon the nomenclature, which is by no means always the case), it is most difficult to obtain information as to the conditions under which the capture was made, even by comparatively recent expeditions. Most naturalists seem to think that they have done enough if the latitude and longitude are given. But, in every case, at least the time of day, the temperature of the horizon of capture, the kind of net and the depth at which it was worked should be recorded. In cases below (pp. 48, 49) where I have not been able to trace contemporary records of the temperature, I have supplied the mean for the position and depth from Dr. Buchan's 'Challenger' Report on Oceanic Circulation as the best approximation; these are marked M.

* In practice, the nine hauls of the small-mouthed net with 180 meshes per linear inch have been found impossible of fair comparison with the other hauls; this net caught practically nothing, while the ordinary nets with 60 meshes were catching a good deal.

Cyphocaris anonyx, Boeck.

Mr. Stebbing here treats his *micronyx* as a synonym of the above species. The previous records of the species thus enlarged are :—

'Challenger' { 1. Sta. 295 ; 38° 7′ S., 94° 4′ W. ; sounding 1500 fathoms, from the tow-net at the trawl. Temperature 35°·3.
2. Sta. 335 ; 32° 44′ S., 13° 5′ W. ; 1425 fathoms, from the dredge *. Temperature 37°.

'Hirondelle' { 3. Sta. 253 ; 47° 38′ N., 22° 13′ W. ; 710 fathoms, "filet bathypélagique à gouvernail" †. Temperature (mean) 42°.

'Oceana'. . { 4, 5, 6. Sta. 4–6 ; 52° N., 15° W. ; open nets lowered to 1670, 1300, and 510 fathoms. Lowest (mean) temperatures, 36°, 37°, 46°.

7. Greenland. Mean annual surface-temperature of Southern Greenland, 35° to 40°.

There can be little doubt that this is a cold-water form. Boeck gives no record of depth with the Greenland specimen in the Copenhagen Museum, but before 1870 it is not likely to have been captured from any considerable depth in a Greenland area.

Jassa pulchella, Leach.

The confusion to which this species was reduced, though lately disentangled by Mr. Stebbing ‡, yet makes it difficult to trace the records of its distribution. It appears to range as a *neritic* form from Norway (but not into the Arctic Ocean) by England, France, and Spain into the Mediterranean § as far as the Bosphorus, occurring also at Teneriffe and the Azores ‖. But, so far as I am aware, it has not been taken as an *oceanic* form previously to this cruise of the 'Research' (47° 5′ N., 7° 45′ W., being roughly 2° 10½′ from the nearest land); but, as Mr. Stebbing reminds me, it readily attaches itself to floating objects, and may have put to sea unadvisedly in this manner. Considering how much is known of northern Crustacea, it seems safe to put its minimum about 44° or 45°, the mean annual of Trondhjem Fjord.

Scina crassicornis (Fabricius).

This species has a wide horizontal distribution. It was taken at the surface near Tristan da Cunha (temp. 65°), and also at the surface between Fiji and Raine Island (temp. 74°), by the 'Challenger.' On the other hand, most of the captures of this (as of other Hyperiids) by the 'National' ¶ were made with the vertical net between 218 or 273 fathoms and the surface ; but this is due probably rather to the enormous catching-power of this net than to the organism having been captured at the lower zones of its course. These, and a haul of the 'Pola' ** at 273 fathoms with the Monaco closing-net

* 'Chall. Rep. Summary of Results,' ii. p. 1224.

† So far as I can ascertain from M. Chevreux's preface, this is the "filet pélagique à rideau" of the Prince of Monaco's paper on gear in Cong. Internat. Zool. i. p. 133 (1890), ordinarily known as the "Monaco net."

‡ T. R. R. Stebbing : Ann. & Mag. N. H. (7) iii. p. 237.

§ G. O. Sars : 'Crustacea of Norway,' Amphipoda, p. 594.

‖ E. Chevreux : 'Amphipodes de l'Hirondelle,' p. 106.

¶ J. Vosseler : 'Amphipoden der Plankton-Expedition,' pp. 116–118.

** T. Garbowski : Denkschr. Akad. Wien, lxiii. Comm. Erforsch. östl. Mittelmeeres (fünfte Reihe), p. 113.

in the comparatively warm water of the Mediterranean, seem to be the lowest strata to which a net containing *Scina crassicornis* has been lowered, but it has yet to be shown that it reaches these not very considerable depths in the Atlantic.

Speaking of the Scinidæ as a whole, Dr. Garbowski says that they exhibit "bathymetrische Indolenz und Eurythermie"; and till closing-nets are more used we must be content with such general statements. But it must be borne in mind that the 'Pola' worked in the Mediterranean only, a "closed sea" where the decrease of temperature with depth is very slight when compared with that in the open ocean; and that at the lowest depth with a closing-net from which Garbowski obtained *crassicornis*, viz. 273 fathoms, the mean temperature is about 56°. A species may be markedly eurybathic in the Mediterranean without being correspondingly eurythermic.

At the same time some species of Scinidæ, e. g. *Clausii*, are apparently eurythermic; but the family seems as a whole to dislike very cold water, since not a *Scina* was recorded by the Norwegian North Atlantic Expedition. The single exception, the one outlier to the North at present known, is *Scina borealis*.

Scina borealis (Sars).

This appears to me to be one of the most interesting finds. Its previous records are most easily expressed in a table:—

Locality.	*Depth in fathoms.*	*Net.*	*Temperature.*	*Authority.*
Lofoten Islands.	300	.....	M. 39°	Sars, Crust. Norw. Amphip. p. 20.
Trondhjem and Christiania Fjords.	100 to 150	Dredge or tow-net near dredge.	M. +45°	Sars, Crust. Norw. Amphip. p. 20.
Færoe Channel, H.M.S. 'Triton.'	300 to 0	Open.	circa 33° to 54°	Norman, Ann. & Mag. N. H. (7) v. p. 135.
Færoe Channel, H.M.S. 'Research,' 1896.	465 to 335	Mesoplankton.	31° to 33°	Fowler, Proc. Zool. Soc. 1903, i. p. 128.
Bay of Biscay, s.s. 'Caudan.'	524 to 0	Open.	M. circa 49° to ?	Bouvier, Ann. Univ. Lyon, Camp. de 'Caudan.'
s.s. 'Fram,' 80° N.	300 to 0	Open.	circa 32°	Norweg. North Polar Exped., Sars, Crust. p. 19.
Bay of Biscay, H.M.S. 'Research,' 1900.	1250 to 0	Open.	38° to 63°	
	750 to 500	Mesoplankton.	48° to 49°	

It seems to be most unlikely that it occurs at the surface or moderate depths in the North Atlantic, as neither the 'Hirondelle,' 'National,' nor 'Buccaneer' met with it. I cannot but think that it will prove to be a purely cold-water form, seeking its optimum temperature at considerable depths in low latitudes.

Hyperioides longipes, Chevreux.

The table of occurrences of this species (p. 53) shows conclusively that at the time of our cruise, and in our area, the 100-fathom horizon was the centre of its vertical distribution. It occurred in:

86	per cent.	of the	22	hauls at	100	fathoms,
36	,,	,,	11	,,	75	,,
15	,,	,,	13	,,	50	,,
8	,,	,,	12	,,	25	,,
0	,,	,,	25	,,	0	,,

and in the two closing hauls 21 *n* (150 to 100) and 21 *p* (150 to 50). It occurred in not one of the 35 "comparable" hauls which closed at various depths below the 100-fathom line. The serial hauls 36 *g*, *h*, *i*, and *k* were open tow-nets, and may possibly have captured it at any depth *less* than that to which they were lowered. It is not certainly apparent from the table that the species rises particularly at night.

The captures by the 'Hirondelle' seem to point to a greater depth, but they would have carried more evidence had any one of them included more than a single specimen; they were as follows:—

Station.	*Position.*	*Depth in fathoms.*	*Temperature,* ° F.	*Net.*
169	44° 42′ N., 9° 16′ W.	269	M. circa 52°	"à ressort" *.
253	46° 38′ N., 22° 13′ W.	710	M. 42°/3°	"à gouvernail" *.
256	48° 24′ N., 20° 38′ W.	1201	M. 38°/9°	,, ,,
258	47° 42′ N., 19° 30′ W.	426	M. 47°/8°	,, ,,

The species described by Vosseler as *Hyperia sibaginis*? does reach the surface rarely; it was captured by the 'National' on 41 occasions, of which no less than 92 per cent. were in vertical, plankton, or other open nets from between 273 or 109 fathoms to the surface; but it was taken at the surface only twice in the open ocean, once in brackish water in the Tocantins (mouth of River Para). Mr. Walker records it from the 'Oceana' collections as having been taken in open nets lowered to 150 and to 510 fathoms.

Parathemisto oblivia (Kröyer).

Owing to the small size of the specimens, Mr. Stebbing expresses himself as not quite certain of the identification. It is noticeable from the table (p. 51) that as it never appears in any of the 22 hauls at 100 fathoms, these small specimens, unlike *Hyperioides longipes* just mentioned, probably do not *live* at that depth; in that case the single specimens from 21 *m*, 21 *n*, and 21 *o* were perhaps adopting a mesoplanktonic habitat; for from the evidence which I have previously adduced †, it seems likely that this supposedly northern species is epiplanktonic when young, mesoplanktonic

* The "filet à ressort" is probably that of Baron de Guerne; the "filet à gouvernail" seems to be the "filet bathypélagique" of the Prince of Monaco.

† Proc. Zool. Soc. 1898, p. 583, & 1903, i. p. 126.

when adult; and the largest of these specimens was only 3·75 mm. The adult has already been recorded * from an open deep net (409 to 0 fathoms) in the Bay of Biscay. Unfortunately the small number of captures on our cruise does not materially increase our knowledge on this point, but does extend the epiplanktonic distribution of the young considerably southwards, Valentia being the most southerly point hitherto recorded to my knowledge.

Euthemisto compressa (Goës).

For the distribution of this form, long supposed to be subarctic, compare Proc. Zool. Soc. 1903, i. p. 127, and Vosseler, 'Amphipoden der Plankton-Expedition,' p. 86.

Primno macropa, Guérin.

This seems to be a nearly cosmopolitan species, at any rate if the synonymy referred to above by Mr. Stebbing be accepted.

Brachyscelus mediterraneus (Claus).

This widely-distributed species was described by Claus from Naples, and recorded by the 'Challenger' at various localities in the North and South Atlantic, always at the surface. By the 'Hirondelle,' in addition to two surface-captures, it was taken with the "filet à gouvernail" from 710 and 1201 fathoms, by the 'Oceana' in open nets lowered to various depths.

Previous records of the remaining species are most easily placed in tabular form (p. 52).

The following table (p. 51) shows the occurrences of the various species of Amphipoda expressed as serial numbers in the list of species. The first three hauls are with the mesoplankton trawl, the remainder with tow-nets; "non-comparable" hauls are marked with a †.

1. *Cyphocaris anonyx*, Boeck.
2. *Eusirogenes dolichocarpus*, sp. n.
3. *Jassa pulchella*, Leach.
4. *Archæoscina Bonnieri*, sp. n.
5. *Parascina Fowleri*, sp. n.
6. *Scina crassicornis* (J. C. Fabricius).
7. *Scina œdicarpus*, Stebbing.
8. *Scina marginata* (Bovallius).
9. *Scina Rattrayi*, Stebbing.
10. *Scina lepisma* (Chun).
11. *Scina borealis* (Sars).
12. *Lanceola æstiva*, Stebbing.
13. *Lanceola pacifica*, Stebbing.
14. *Vibilia armata*, Bovallius.
15. *Vibilia propinqua*, Stebbing.
16. *Phronima sedentaria* (Forskål).
17. *Hyperia luzoni*, Stebbing.
18. *Hyperioides longipes*, Chevreux.
19. *Parathemisto oblivia*? (Kröyer).
20. *Euthemisto compressa* (Goës).
21. *Primno macropa*, Guérin.
22. *Brachyscelus mediterraneus* (Claus).
23. *Brachyscelus*, sp. indet.

* J. Bonnier: Ann. Univ. Lyon, Campagne de 'Caudan,' p. 611.

Horizon.	Haul.	Species.
500—250	29 *a*†	
1500—750	30 *a*†	
2000—1000	30 *e*†	2, 12
0	21 *e*	23
	21 *f*†	
	21 *i*	19
	22 *d*	
	22 *e*†	19
	22 *g*	
	23 *b*	
	23 *c*†	
	23 *d*	
	23 *e*	
	24 *c*†	19
	24 *f*	3
	24 *g*	19, 23
	24 *h*†	
	24 *i*	3, 19
	24 *k*†	
	25 *a*†	
	25 *b*	19
	25 *h*	
	25 *i*	
	25 *l*	19
	30 *c*	
	32 *c*†	
	33 *a*†	6, 19
	33 *b*	
25—0	26 *a*	
	30 *b*	
	30 *m*	
	31 *a*	
	32 *b*	19
	32 *e*	19
	33 *e*	18
	33 *g*	
	34 *a*	6
	34 *g*	19
	35 *w*	
	36 *c*	15
50—0	21 *g*	19
	25 *e*	21
	25 *g*	18
	25 *k*	
	26 *c*	19
	30 *d*	19
	30 *l*	6
	31 *b*	6, 14, 21, 22
	32 *a*	18
	32 *h*	19, 21
	33 *c*	
	33 *f*	19
	36 *d*	
75—0	30 *f*	
	32 *g*	18, 19
	32 *m*	19, 21
	32 *o*	9
	33 *h*	18
	34 *c*	6
	35 *a*	
	35 *c*	
	35 *e*	18
	35 *g*	16, 18
	36 *a*	
100—0	21 *h*	18
	21 *l*	
	22 *a*	18
	24 *b*	18
	24 *d*	18
	24 *e*	18
	25 *d*	18
	30 *g*	18
	30 *h*	18, 21
	32 *d*	7, 18, 20
	32 *i*	18
	32 *n*, *n*′	18, 13
	32 *p*	18
	33 *d*	18, 23
	34 *b*	13
	34 *d*	17, 18
	35 *b*	18
	35 *d*	18
	35 *f*	16, 18
	35 *x*	6
	36 *b*	18
	36 *e*	18
150—0	36 *f*	7
150—50	21 *p*	18
150—100	21 *n*	18, 19
200—0	21 *a*	
	36 *g*	18
200—100	21 *b*	
	21 *o*	19
	26 *e*	
	34 *h*	
	35 *m*	
	35 *n*	
	35 *t*	
250—0	36 *h*	18
	36 *i*	18
250—150	35 *o*	
	35 *p*	8
	35 *s*	
300—0	36 *k*	10, 18
300—200	21 *c*	
	26 *f*	
	35 *l*	
350—0	36 *l*	12
400—300	21 *k*	1
	32 *l*	1
	35 *k*	4
500—400	21 *m*	19
	35 *h*	
	35 *i*	
750—500	22 *b*	
	30 *k*	
	34 *e*	11
	34 *f*	
1000—750	23 *a*	
	27 *c*	
	31 *d*	
	32 *f*	
	32 *k*	
1250—1000	24 *a*	
	27 *b*	
	31 *c*	
1500—1250	25 *f*	
	30 *i*	
2000—1500	25 *c*	
	26 *b*	5

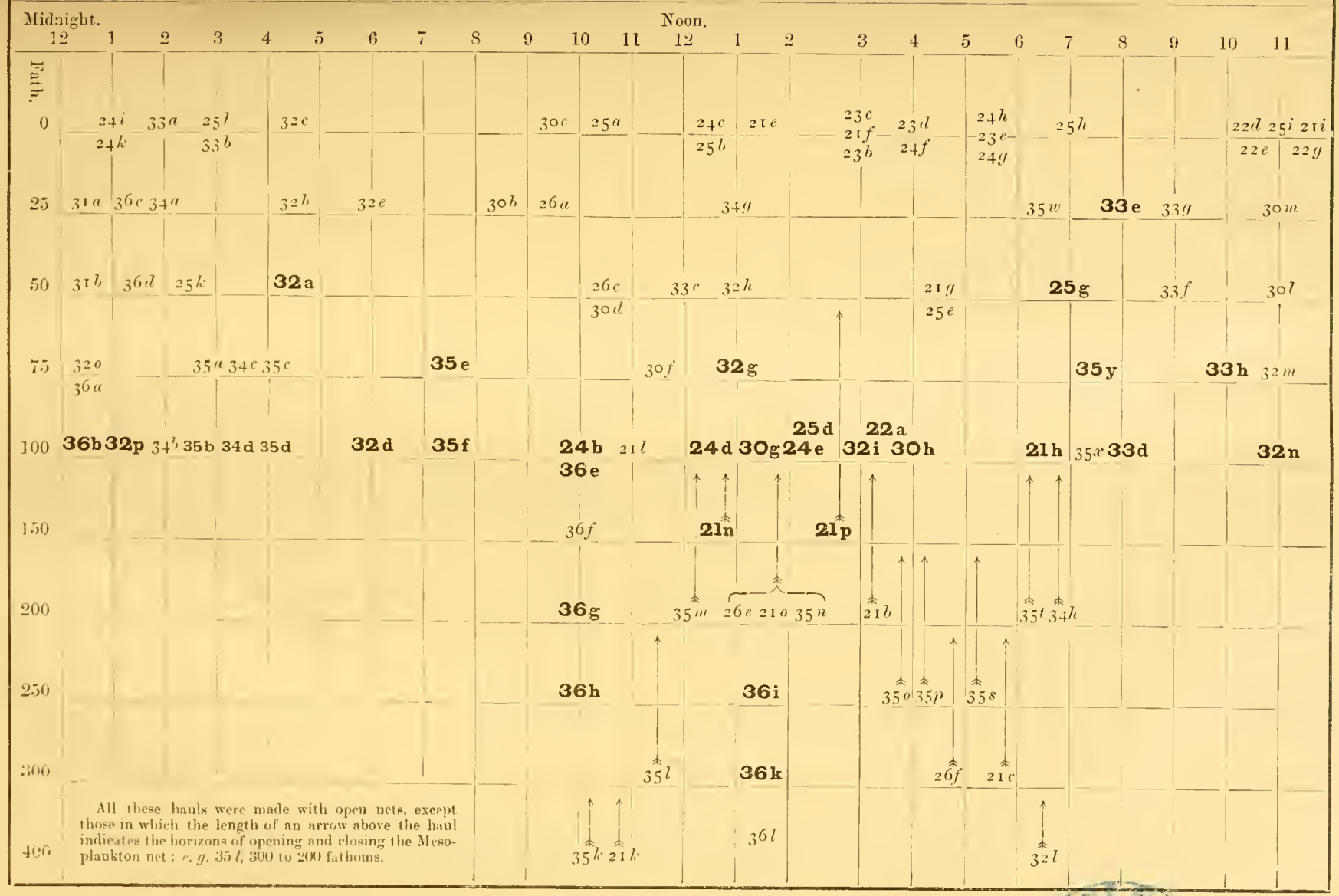
Species.	*Locality.*	*Depth in fathoms.*	*Net.*	*Temperature,* ° F.	*Authority or Ship.*
Scina œdicarpus, Stebbing.	7° 1′ N., 15° 54′ W.	"From a depth of 100 fathoms."	Open.	M. 56° to 82°	'Buccaneer.'
Scina marginata (Bovallius).	Warm Atlantic.	109 or 218 to 0	Vertical & trawl.	M. 60° to 79°	'National.'
	47° 38′ N., 22° 18′ W.	710	? Monaco closing.	.....	'Hirondelle,' Sta. 253.
	Mediterranean.	Various.	.....	.....	Various.
Scina Rattrayi, Stebbing.	1° 55′ N., 5° 55′ E.	"After 9.0 P.M. from a depth of 360 fathoms."	Open.	circa 42° to 82°	'Buccaneer.'
	47° 4′ N., 19° 30′ W.	426	? Monaco closing.	circa 47°/8°	'Hirondelle,' Sta. 258.
	Various parts of warmer Atlantic.	218 to 0	Open vertical.	M. 47° to 80°	'National.'
		1670 to 0	Open serial.	Various.	'Oceana.'
Scina lepisma (Chun).	Between Teneriffe and Grand Canary.	874 to ? 0	? Closing-net.	M. 44° to ?	Chun, SB. Akad. Berlin. 1889, p. 533.
Lanceola astiva, Stebbing.	8° 37′ S., 34° 48′ W.	675	Trawl.	circa 38°	'Challenger,' Sta. 120.
	1° 47′ N., 24° 26′ W.	1850	Trawl.	36°	'Challenger,' Sta. 106.
Lanceola pacifica, Stebbing.	35° 41′ N., 157° 42′ E.	2300	Trawl.	35°	'Challenger,' Sta. 241.
Vibilia armata, Bovallius.	South and Tropical Atlantic.	.....	.....	.....	Bovallius, Svenska Vet.-Ak. Hdlgr. xxi. p. 69.
	S. Equat. Atlantic.	273 or 218 to 0	Open vertical.	M. 44° to 78°	'National.'
	N.E. Atlantic.	790 to 0	Open serial.	M. 40° to 55°	'Oceana.'
Vibilia propinqua, Stebbing.	25° 30′ N., 138° 0′ E.	Surface.	Open.	78°·5	'Challenger.'
	Warm Atlantic.	273 or 218 to 0	Open vertical.	M. 47° to 82°	'National.'
Hyperia luzoni, Stebbing.	16° 35′ N., 117° 47′ E.	Surface.	Open.	76°·5	'Challenger,' Sta. 206–7.
	10° 14′ N., 123° 54′ E.	Surface.	Open.	circa 80°	'Challenger,' Sta. 209.
	38° 6′ S., 88° 2′ W.	Surface.	Open.	59°·8	'Challenger,' Sta. 296.
	Warm Atlantic.	218 or 109 to 0, once at surface.	Vertical and Plankton nets.	M. 49° to 79°	'National.'

II. THE CLADOCERA.

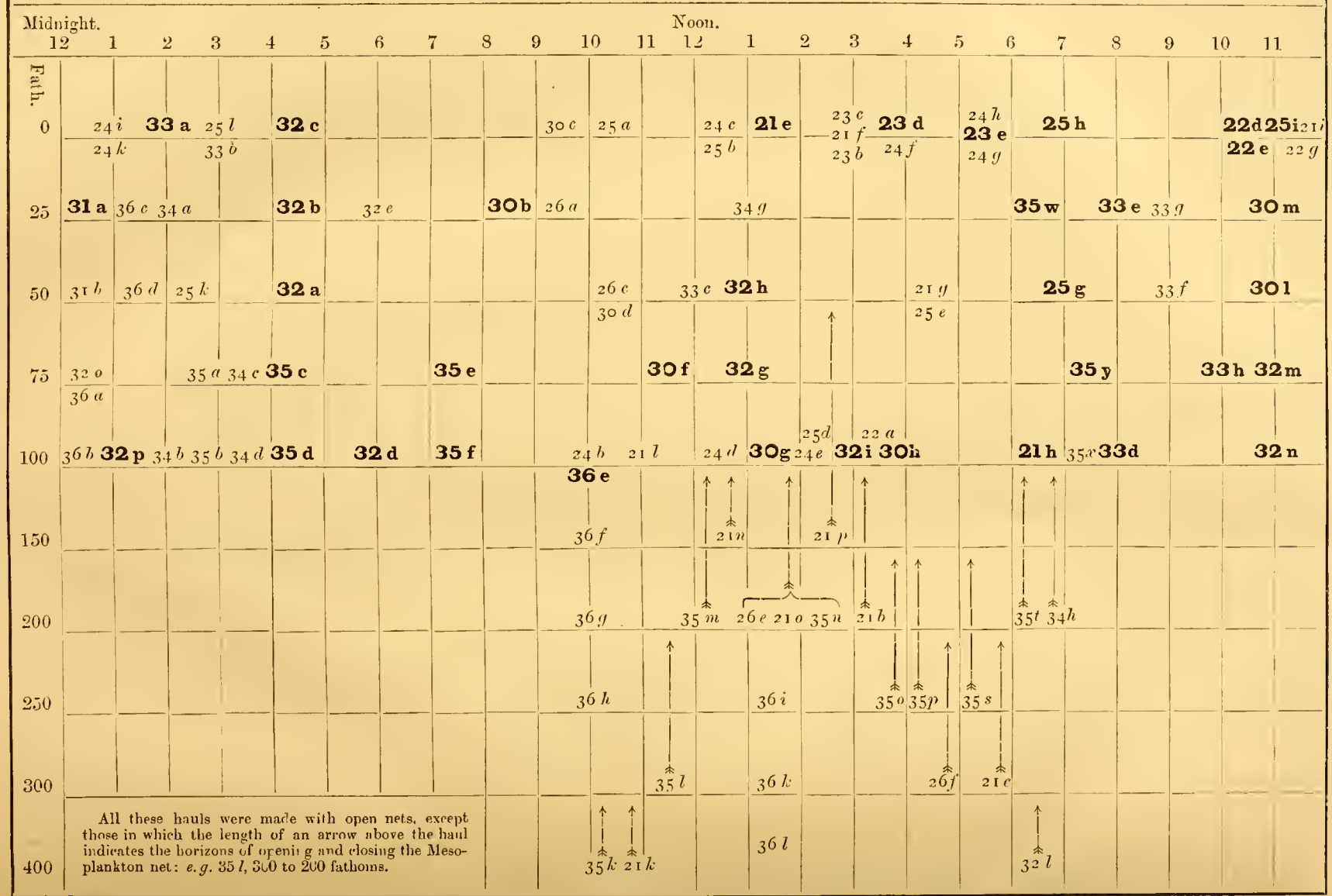
Evadne Nordmanni, Lovén.

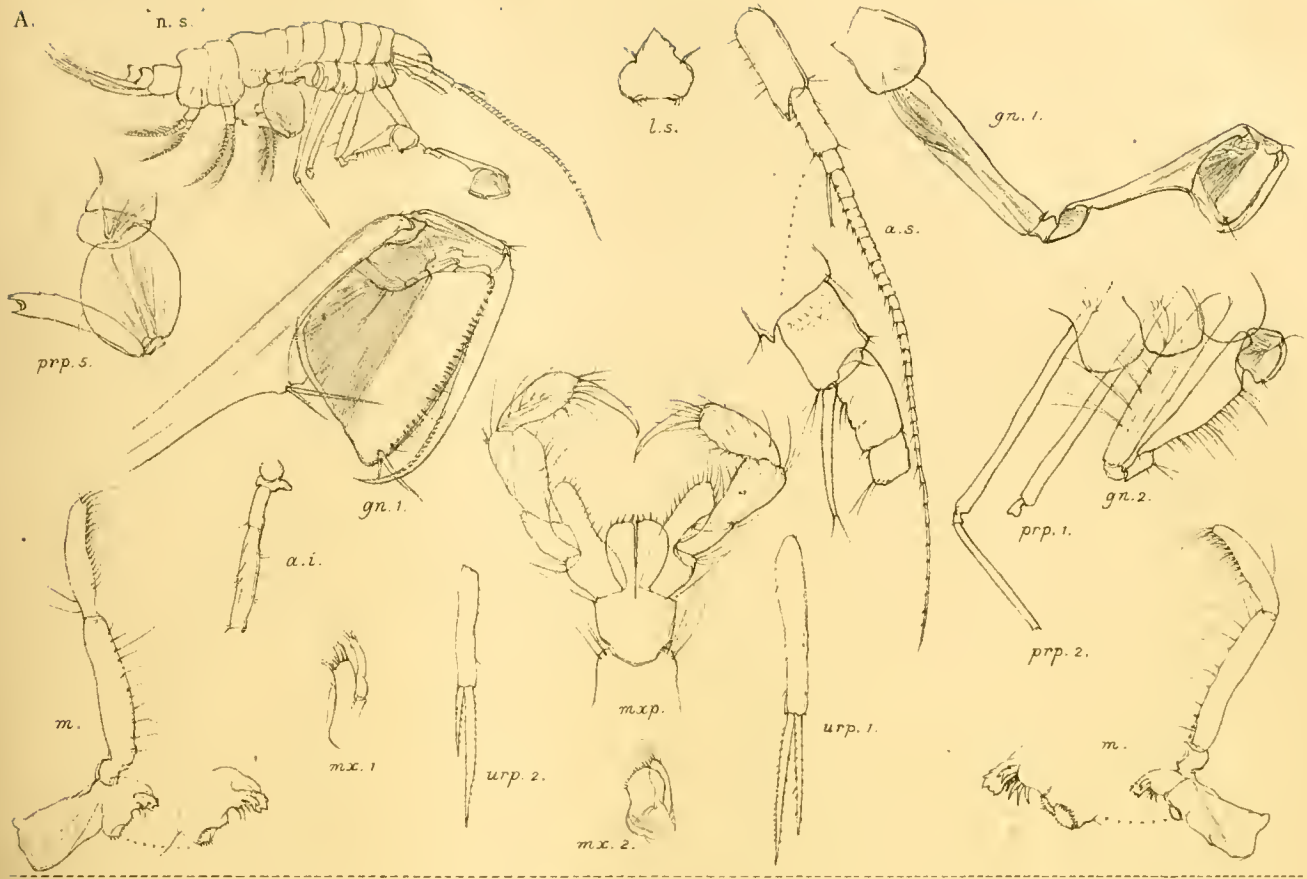
There can be little doubt from the table (p. 54) that this is a truly epiplanktonic species. It occurred plentifully in 42 per cent. of the hauls between 100 and 0 fathoms. Single specimens also occurred in only two out of the possible 36 hauls which closed before or at the 100 fathoms (34 *e*, 750 to 500 fm.; 31 *d*, 1000 to 750 fm.).

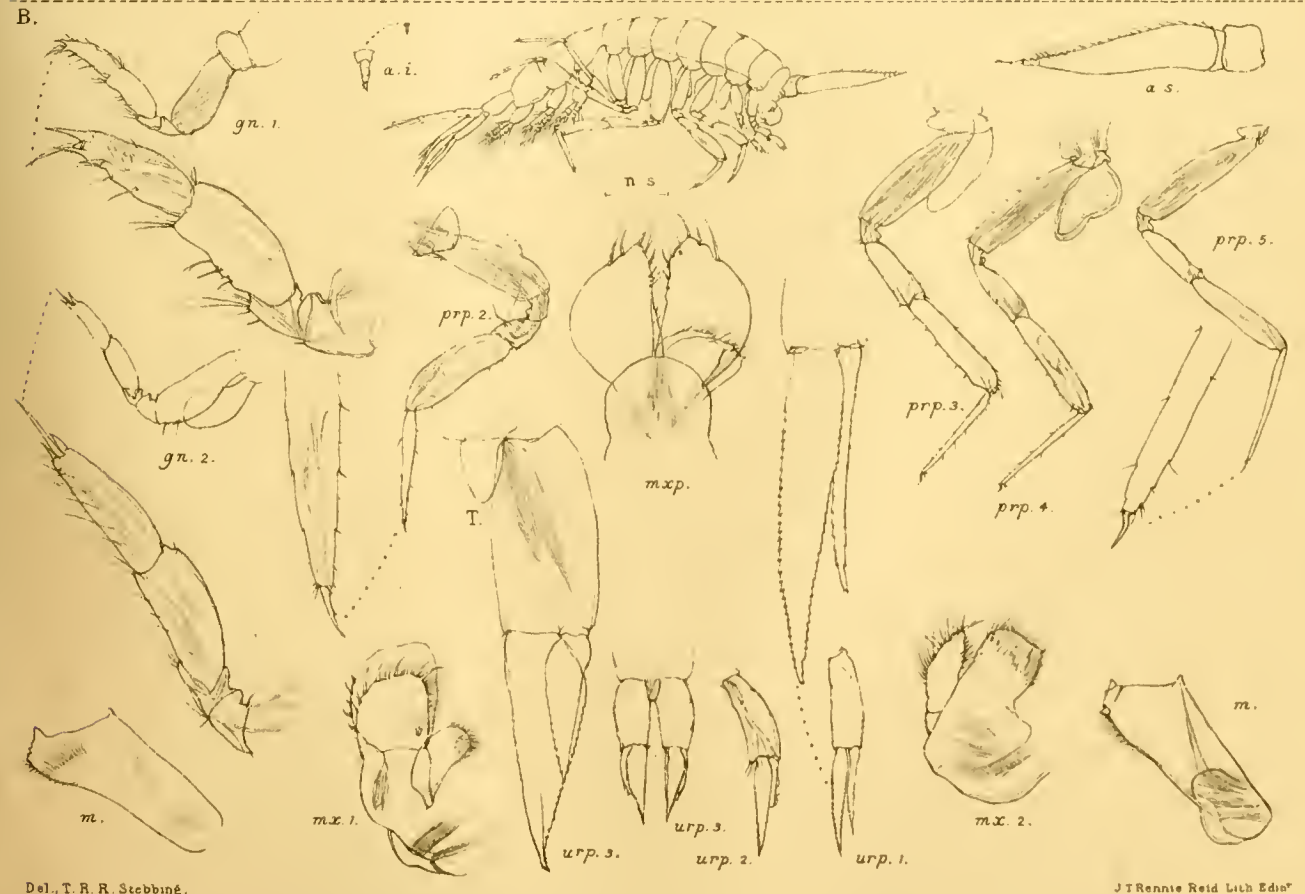
EPIPLANKTON AND UPPER MESOPLANKTON.



EPIPLANKTON AND UPPER MESOPLANKTON.



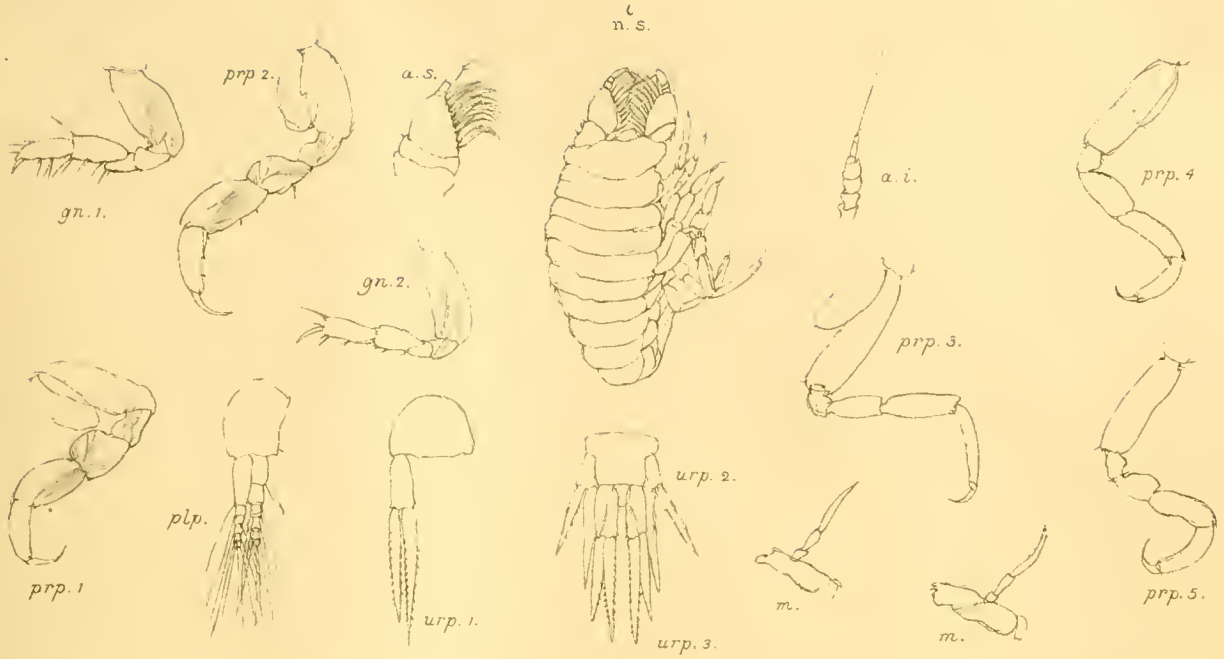




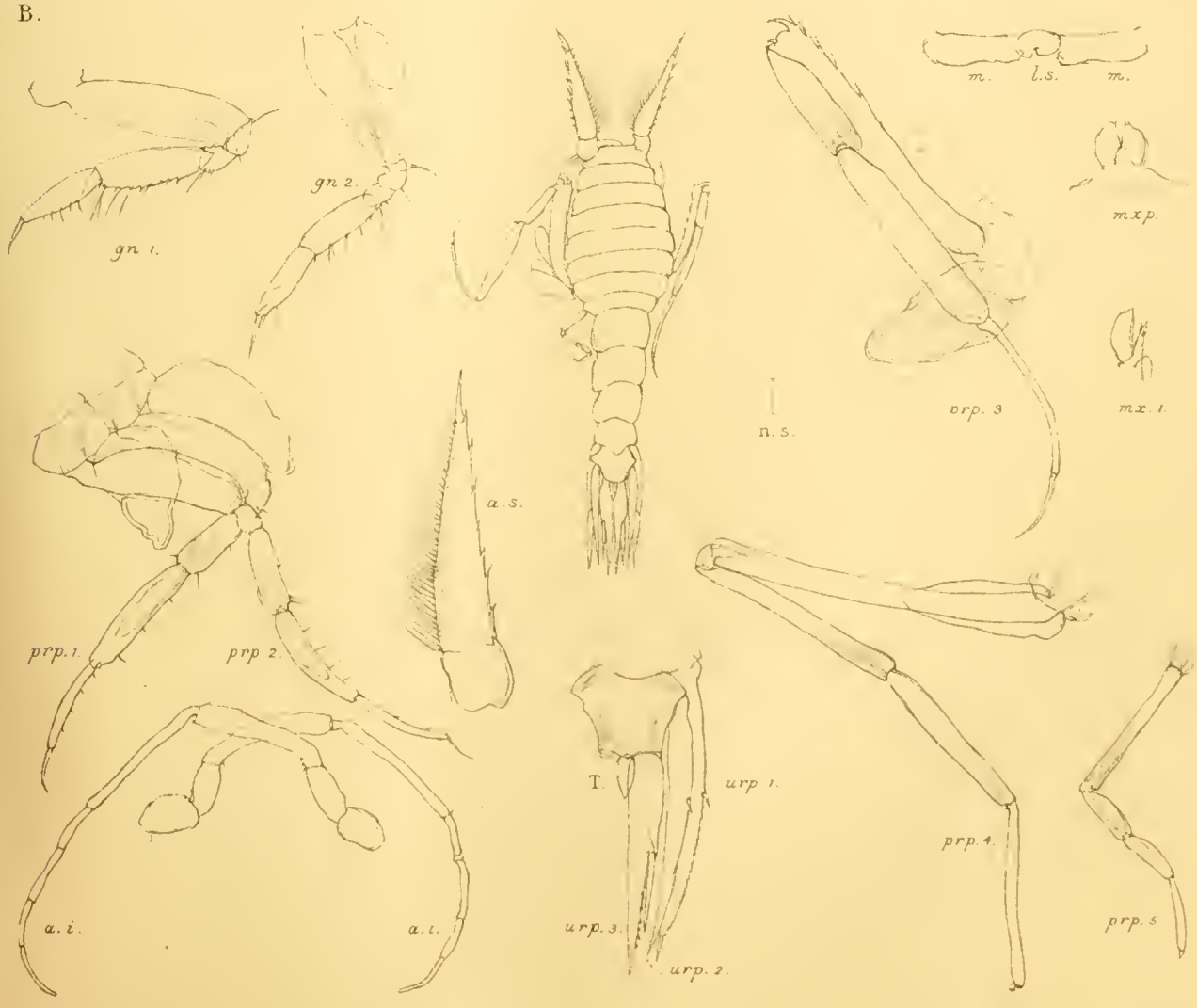
Del., T. R. R. Stebbing. J T Rennie Reid Lith Edin^r

A. EUSIROGENES DOLICHOCARPUS, n.g.et.sp. B. PARASCINA FOWLERI, n.g.et.sp.

A.



B.



Del. T R R Stebbing

J T Rennie Reid Lith Edin^r

A. ARCHÆOSCINA BONNIERI, n g et sp.

B. SCINA LEPISMA (CHUN)

BISCAYAN PLANKTON.

Part III.—THE CHÆTOGNATHA.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S., F.Z.S.*

(Plates 4–7.)

Read 2nd June, 1904.

MARINE BIOLOGICAL LIBRARY WOODS HOLE MASS

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On the Systematic Determination of Chætognatha.

BISCAYAN PLANKTON: Part III. CHÆTOGNATHA.
(Trans. Linn. Soc., Ser. 2, Zool. x. 55–87.)

Temporary correction-slip.

Page	Line	
57	6	*Add*: "In the measurements of 'total length' and of 'tail-segment,' the tail-fin has been included, greater accuracy with less damage to the specimen being attained thereby."
58	5 from bottom.	*For* "body" *read* "trunk."
63	7	,, ,, ,,
67	10	,, ,, ,,
69	3	*Add*: "A slight short thickening of epidermis behind the head, scarcely enough developed to be termed a collarette."
69	7	*For* "body" *read* "trunk."
78	5 from bottom.	,, ,, ,,
78	2 from bottom.	*For* "usually" *read* "unusually."

* Perhaps this sweeping statement may be held to require justification. Among recent papers, one [illegible] measurements showing the tail-segment of a species to be 24 per cent., or nearly a quarter, of the total length, but draws it 31 per cent., or nearly a third. Another writer says that "the posterior fins touch the vesiculæ seminales," yet draws them far apart; in another species he describes the tail-segment as a fourth of the whole length, and draws it as 35 per cent., or more than a third. When one finds such inaccuracies in easily measurable matters, absolutely no reliance can be placed on the figure as a whole.

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On the Systematic Determination of Chætognatha.

Considering the comparatively small number of species, few animals can be more troublesome to identify than a large collection of Chætognatha. This results not only from the inadequate diagnoses by many of the earlier describers, but also from the scarcity and variability of the external diagnostic characters, the considerable differences in the proportions to one another of the various parts (produced in the less firm species by varying degrees of expansion and contraction), and the difficulties of satisfactory preservation.

Taking these points in a little more detail—Oscar Hertwig reduced to order such species as came under his notice, but unfortunately these were not numerous. Had all later observers given equally careful descriptions, our task to-day would have been easier; but, as it is, cursory descriptions of a few external features, taken apparently, in many cases, from only one or two specimens, are the rule in the literature of the subject. Almost more trouble has been caused by inadequate drawings *; considering how closely alike at first sight are even such undoubtedly "good" species as *hexaptera* and *enflata*, no freehand drawing of the outline of a *Sagitta* can be trusted, because a quite small error in the proportions of head, body, tail, and fins may easily give the misleading outline of another species. Every reporter on a collection of Chætognatha, who desires to help in placing the genera and species on a proper footing, should give an

* Perhaps this sweeping statement may be held to require justification. Among recent papers, one author gives measurements showing the tail-segment of a species to be 24 per cent., or nearly a quarter, of the total length, but draws it 31 per cent., or nearly a third. Another writer says that "the posterior fins touch the vesiculæ seminales," yet draws them far apart; in another species he describes the tail-segment as a fourth of the whole length, and draws it as 35 per cent., or more than a third. When one finds such inaccuracies in easily measurable matters, absolutely no reliance can be placed on the figure as a whole.

outline drawing by *camera lucida* of a typical specimen of every species, however well known, wherever possible.

As regards the variability of diagnostic characters, it seems to be very desirable that for every species in every collection (however common) a table should be furnished showing at least the proportion of tail to total length, with the numbers of jaws and teeth *at different lengths*, until such time as we shall have gained some idea of the variability within the limits of each species. More measurements would be desirable, but are often impossible owing to the imperfect condition of the specimens.

As regards preservation, the material from the 'Research' and from the 'Siboga' Expeditions leads me to believe that the best method is to preserve each specimen separately in formalin, at first weak, then in a stronger solution (5–7 per cent.). Neither sublimate, picric acid, osmic acid, nor spirit (alone or in combination with the foregoing) gives such good results *.

Some characters which have been used in diagnosis seem to require clearing away. The projection, size, and shape of the vesiculæ seminales appear to depend entirely upon the sexual condition of the individual at the moment of capture. The size of the ova seems to me also to be valueless, since one cannot always tell whether they are ripe or not. The extension forwards of the ovaries has more significance, but too much stress must not be laid upon it; for example, the mature ovaries reach to the neck in *robusta*, never (so far as I have seen) more than halfway to it in *enflata*, but a developed ovary of *enflata* and a half-grown ovary of *robusta* are of the same length and have ova of nearly the same size. Drawings and measurements of the head are diagnostically almost valueless—its shape, proportions, and apparent size alter so enormously according to the condition at death, with the extension forwards, outwards, or inwards of the jaws, with the retrusion into the prepuce, &c.

The presence or absence of two diverticula on the alimentary canal in the neck has been used diagnostically by recent writers: so far as my experience goes, these depend on the extent of protrusion or retrusion of the head; at any rate within the limits of the same species I have found some specimens with, and some without, these diverticula.

The colour of the body does not appear to be diagnostic: specimens from deep water are often of a salmon-pink; but in the same hauls some specimens of *hamata* and *macrocephala* were pink, others colourless.

If specimens were always perfectly preserved, the fins would be a good guide to species, and in many cases are of some value when present; but they are so often shrunken, torn, or rubbed away as to be of no help. The form of the corona ciliata is useful, when it is retained on a specimen (by no means always the case) †.

* So far as Chætognatha were concerned, I committed a great error in making the epiplankton hauls too long (generally one hour: half an hour would have been preferable). Specimens which are caught early in the haul become compressed against the sides of the net, and the prolonged pressure flattens and otherwise damages them considerably (*cf.* the account of *S. furcata*, p. 64). More numerous hauls of shorter duration would have yielded better specimens and would ultimately have saved time, at a slightly greater expenditure on bottles, cases, &c.

† In order to see this, and to make outline camera drawings of the whole animal, I have found nothing better than a 1 per cent. solution of methyl blue, used for about one minute. The colour soon fades, and leaves the specimen uninjured for museum purposes. In drawing, I have found the Giltsch-Zeiss support, used with an Abbé camera, invaluable.

It may, then, be asked, what is left by which to distinguish the species of Chætognatha? The general outline of the body counts for something; that is to say, the proportion of head to body, the position of the thickest part of the body, the ratio between the lengths of the postanal region and the trunk. Of these only the last one can, as a rule, be safely expressed in measurements, as the proportions of head and body vary so much with the extent of the death-contraction. Other fairly fixed characters are the presence or absence of a constriction between head and body to form a "neck"; a lateral expansion of the ectoderm at this point *; a sudden diminution of the body-diameter at the anus as contrasted with a gradual tapering, or a marked constriction at the septum †.

The consistency of the body is of some value: those species with comparatively large longitudinal muscles and small muscle-free lateral fields (e. g., *bipunctata*) have a firmer consistency, and in formalin a more opaque appearance, than species with comparatively poor musculature and large lateral fields, such as *hexaptera*; these seem flabby and transparent in formalin, and often have a wrinkled appearance, if not very carefully preserved when alive.

As regards the lateral fins, if well preserved, a comparison of their width with that of the body, and a comparison of the widths and lengths of the two pairs, are more safely expressed by camera drawings than by measurements; their extension forwards as tested by the ventral ganglion, backwards as tested by the vesiculæ seminales, centrally as regards the anal septum, are of great value. The tail-fin is less instructive; its extension forwards as regards the vesiculæ seminales is useful, but its outline is very readily damaged, and a truncate fin easily splits into an apparently bilobed one, or wears into an ensiform shape. Too much stress must not be laid, except in perfectly preserved material, on the triangular or elliptical outline of the posterior fins: it is quite easy to find specimens (*e. g.*, of *furcata*) with an almost triangular fin on one side which had been rubbed into an ellipse on the other.

The most stable parts of a Chætognath are formed by the cephalic armature—the jaws (*cirrhi*, *uncini*) and teeth ‡. These are often the *only* characters by which to identify a badly preserved specimen, but they must be used with care, since, as I shall show later in dealing with the various species captured, they are liable to considerable variation. Still, allowing a considerable latitude for these variations, their mere numbers afford a fairly accurate criterion when taken in conjunction with the characters already cited. If to these be added a detailed study of the jaw-structure, such as Dr. Krumbach § has recently worked out for several species, the observer may feel

* For this, which has been termed a "neck-fin," I have used the name "collarette."

† Dr. Krumbach writes that he has worked out the form of the tail-segment as a diagnostic character for Mediterranean species.

‡ The counting of these is often troublesome. I use two short slips of glass cut from a slide, lay one across the dorsal surface of the specimen just behind the head, and then, bending the head upwards and backwards with a needle, prevent it from falling forwards again by pushing the second glass slip up against it; and drop a cover-glass on the whole. This enables one to study the armature from the anterior end, and generally to count the teeth and jaws readily.

§ Th. Krumbach: "Ueber die Greifhaken der Chätognathen," Zool. Jahrb. (Abth. Syst. u. s. w.) xviii. 579 (1903).

himself on safe ground. As a secondary character, I find the form of the vestibular ridge, which lies just in front of the posterior teeth, to be of assistance. In many cases below, the anterior and posterior teeth have been figured, but I doubt whether such drawings have much value; the teeth look so different when viewed at different angles.

Examination of the 'Research' Specimens.

The first hauls examined were dealt with very carefully; the dimensions of every specimen taken, and the jaws and teeth counted, until every common species had the look of a familiar friend. After that, the epiplankton hauls were sorted, chiefly by a dissection-lens, measurement and counting being done only in cases of doubt, or as an occasional check on sorting by eye. Of the mesoplankton hauls, on the other hand, every specimen (except a few young *zetesios*) was measured and counted and identified with care. When the whole collection had been thus sorted into species, every specimen was re-examined; and as there were over 2100 specimens, the task has not been light.

It is therefore possible, though not likely, that a few "*hexaptera*?" have been mistakenly assigned to *furcata*. Mistakes are especially likely to occur with very young specimens (one species excepted), and they have therefore not been recorded when in the least doubtful: small specimens are often impossible of determination in the present state of our knowledge, because the numbers of jaws and teeth are then small, and the proportion of tail to trunk is generally higher than in older specimens; even the character of the jaws alters with age in some species. The one exception referred to above is fortunately the interesting *hamata*, the hooked jaws of which are recognizable even at 5·5 mm. total length; in young *serratodentata* the younger (dorsal) jaws alone are hooked, and more slightly so than in *hamata*.

Sagitta serratodentata, Krohn. (Pl. 4. figs. 1–6.)

Characters.—Head small; body slender, pin-like like *bipunctata*, thickest about the middle of its length, tapering gradually forwards and backwards; a marked neck, but no collarette; body firm, retaining its shape. Longitudinal muscles broad, but thin; lateral fields rather narrow; no marked constriction at the septum.

Anterior fin long, extending to ventral ganglion, widest near its posterior end. Distance separating the anterior and posterior fins very short. Posterior fin long, longer and wider than the anterior, extending to (or very nearly to) the vesiculæ seminales; about as much on body as on tail; widest point about midway between septum and vesiculæ seminales. Tail-fin truncate.

Ventral ganglion of medium size, prominent. Corona ciliata long, sinuous, extending from between the eyes to about halfway to the ventral ganglion. Jaws strongly curved; the younger (dorsal) jaws serrated and slightly hooked at the tip *. Teeth of

* For a detailed description, see Krumbach, Zool. Jahrb. Syst. xviii. (1903) 579.

both rows comparatively short and triangular. Vestibular ridge with rounded prominences fewer than the teeth, ridge about the same length as the posterior row.

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
15	26	6–7	6	12
14	25–28	6–7	5–6	10–11
13	22–34	6–8	6–7	8–12
12	25–29	7	4–7	8–13
11	27	8	6	9
10	30–35	7	4–6	7–10
9	27–33	6	4	5–6
8	25–31	6–7	3–4	6
7	28–35	6–7	3–4	2–6
6	30	6–7	3–4	5–6
5	30–36	6	2–3	3–4

General Distribution.—The general table of Chætognath occurrences and the table of average specimens following show that this form is essentially epiplanktonic. Plentiful at all horizons to 100 fathoms, it yielded only a single damaged specimen below that level in the closing-net (21 *b*, 200 to 100 fathoms). It occurred, naturally enough, in the open serial nets lowered to greater depths, but may have entered these at any point. The captures with open nets are analysed in the table following *:—

At fathoms this species occurred in	per cent. of the hauls, with	average specimens per hour haul †
0	62	8·6
25	66	4·0
50	76	9·6
75	81	3·4
100	90	5·3
150	1 haul, with	1·0
200	1	1·0
250	0	0·0
300	1	1·5
350	1	1·0

It is fairly obvious from the percentages of hauls in which the species occurred that the expectation of meeting with *serratodentata* increases with the depth down to

* This table is to be read as a sentence from left to right.

† Throughout the discussion of distributions, the "average specimens" are averaged over *all* hauls at the depth mentioned; not merely over those in which the species occurred. See also note † on next page.

100 fathoms. The average expectation of specimens would seem to be greatest at the surface and 50 fathoms, time of day and other variants being neglected.

From the facts cited above it is obvious that the distribution of this species is between the surface and 100 fathoms, possibly but improbably, a little deeper.

Reaction to Time of Day, Light, Rain, &c.

The hauls with open nets in the epiplankton were arranged, so far as circumstances allowed, to test the alleged nocturnal rise and diurnal fall of the fauna of the upper strata, and the effect on it of varying physical conditions. I have endeavoured—with great elaboration, but very little success—to use *serratodentata* as a test-case, since it was fairly plentiful at the higher levels.

In the first place, when arranged on the time-depth tables *, the occurrences show no indication whatever of a nocturnal rise and diurnal fall.

In the second place, with regard to the reaction of this species to light, I adopted Mr. E. W. L. Holt's suggestion of a photographer's actinometer (*cf. suprà*, p. 6).

The numbers of specimens captured † were arranged by light-intensity at the various depths down to 100 fathoms into six groups, according as the sensitive paper of the actinometer reached the standard tint at 2″, 3″ to 6″, 7″ to 10″, 11″ to dusk or dawn, or as the night was dark or brightly moonlit. The only thing that seemed definitely to come out of this attempt was the negative proposition that *serratodentata* has no special affection for moonlight, since six hauls in bright moonlight produced in all but five specimens. On the other hand, the largest numbers of specimens taken at the surface occurred in a 2″ light (48 specimens) and between 11″ and dusk (51 specimens), so that the actual light-intensity of the moment in daylight does not seem materially to affect its presence at the surface.

Now, although the light-intensity of the moment *in daytime* does not seem to affect the distribution of *serratodentata*, nevertheless it would seem that there exists an oscillation of this species, but it is the exact contrary of that generally alleged to affect the epiplankton. Dividing the upper hauls into three groups:—(1) daylight, 3 A.M. to 7 P.M.; (2) night, 7 P.M. to 3 A.M.; (3) hauls taken during or after rain, irrespective of the time of day, and not reckoned under (1) and (2): then we have the following table, showing the average, the maximum, and the minimum number of specimens captured:—

* Reproduced on p. 62: the occurrences of the species are marked in heavy type. The construction is described on p. 7 (*suprà*).

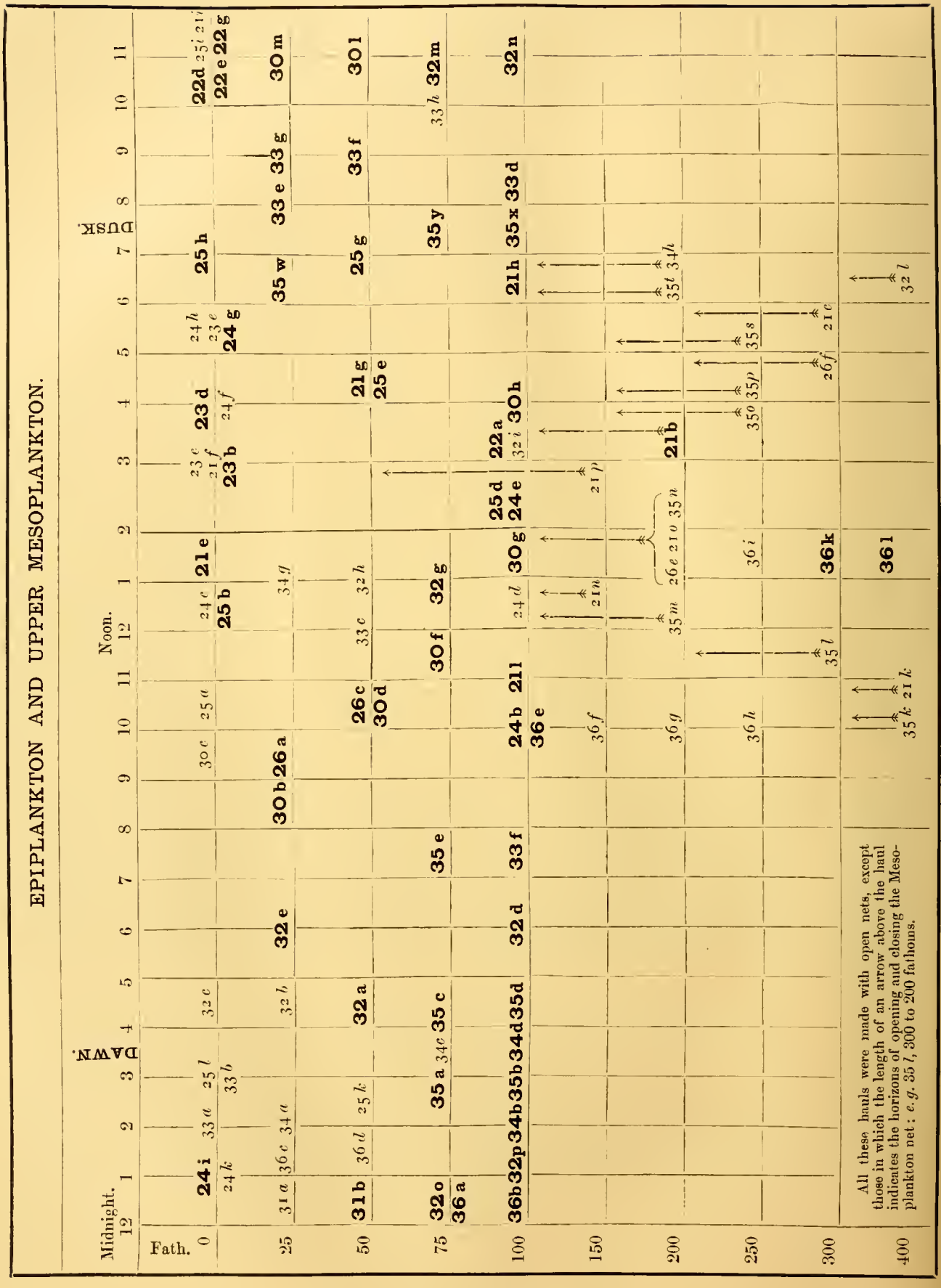
† In these calculations, nine surface-hauls made with a net of 180 meshes per inch linear have been omitted, as it was obvious from a comparison with other nets of wider mesh out at the same time that its small mouth and small filtering area made it useless for catching *Sagitta*. The numbers actually caught have been treated with a time-factor to bring them to the standard one-hour haul, which was the usual period: for example, the numbers taken in a half-hour haul have been multiplied by 2, those taken in a two-hour haul divided by 2, &c. Single specimens, however, have not been divided.

Depth.	Number of hauls.	Day, Night, or Rain.	Specimens.		
			Average *.	Maximum.	Minimum.
0	6	D.	22·1	51	2
	8	N.	0·6	2	0
25	5	D.	4·6	17	0
	4	N.	1·2	3	0
50	7	D.	9·8	28	0
	3	N.	0·6	2	0
75	4	D.	4·0	6	1
	6	N.	1·5	6	0
100	11	D.	5·0	20	0
	9	N.	2·6	6	1
0	2	R.	0·5	1	0
25	3	R.	6·6	8	6
50	3	R.	18·3	28	11
75	1	R.	13·0	13	13
100	2	R.	19·0	28	10

The observations are by no means so numerous as one could wish, but on a comparison with the average catch per haul already given, it will be admitted that this table appears to bring out clearly two points:—Firstly, that the species seeks the surface in daylight hours and shuns it at night; secondly, that during or after rain it descends, being caught in the largest numbers between 50 and 100 fathoms. The two rain-hauls at the surface were in the bright hours of daylight, when the average catch is 22·1 specimens.

The average daylight catches at all depths except the surface are very close to the averages taken over all hauls, whereas the average night catches are well below those general averages. I cannot account for this, except on the assumption that the species shoals at the surface by day and scatters below by night. Although I never worked below 100 fathoms at night, I do not believe that this species sinks below that horizon under any conditions of life, otherwise I should almost certainly have taken, at any rate, occasional specimens in the daylight of early morning or late evening in the closing-net.

* Averaged over all hauls, whether the species was captured or not.



SAGITTA SERRATODENTATA, Krohn.

SAGITTA FURCATA, Steinhaus*. (Pl. 4. figs. 7–15.)

Characters.—Head comparatively small; body thick; neck not well marked in well-preserved specimens; no collarette. Body nearly equally thick throughout the middle third, tapering gradually towards the head, very rapidly to the tail; generally a marked constriction at the septum. Longitudinal muscles broad but thin; lateral fields large; the body is therefore transparent and flabby, easily compressed in the tow-net.

Posterior fin oval (elliptical), never quite triangular, about two-thirds on the body, one-third on the tail; its widest part well in front of the septum; it ends at some distance from the vesiculæ seminales, but extends anteriorly nearly to the anterior fin. Anterior fin widest posteriorly, but not so wide as the posterior fin; it extends nearly to the ventral ganglion. Tail-fin rounded and (? always) bilobed.

Ventral ganglion small. Corona ciliata resembling that of *hexaptera*, but almost entirely on the head, just reaching the neck.

Jaws strong and markedly curved. Teeth long, strong, sharp.

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
35	17	6–8	5–7	11–12
33	17–18	7–8	7–8	9–10
31	18–20	8–9	6–7	9–11
28	18–21	7–8	6	9–11
26	19–21	8–9	6	10
23	19	8–9	5	8–9
21	18–21	7–9	5	7–8
19	18–21	7–8	5–6	6–8
17	17–23	8–9	4–5	7–8
15	20–23	8–9	4	6
13	17–23	8–9	4–5	5–7
12	24–25	8	3	5–6

These characters do not in every respect agree with those given by Steinhaus, notably as regards the fins. But from his mention of the "eigenthümliche Runzelung der Epidermis," I gather that his specimens, like the majority of mine, had suffered severely in the tow-net. As I was in some doubt as to the identity of my specimens with *furcata*, Dr. Krumbach, with some of Steinhaus's specimens before him, was kind

* O. Steinhaus: 'Die Verbreitung der Chætognathen im südatlantischen und indischen Ozean.'

enough to inform me that they are specifically identical, even when tested by his new criterion of the character of the tips of the jaws.

No species, to my knowledge, alters more from damage in the tow-net and from faulty preservation than this. In transparent and well-preserved specimens (fig. 7) the lateral fields may shrink inwards so as nearly to carry the anterior fins out of sight; such specimens are slightly flattened laterally. But in specimens caught early in the haul, which were crushed by pressure of the water against the net and were dead before preservation, notably in such specimens when preserved with picric acid, the trunk, or the tail, or more often the whole body, has a corrugated appearance, and the epidermis stands out laterally in a broad selvage, due partly to mechanical dorso-ventral compression, partly, I think, to an actual loosening of the epidermis from the subjacent tissue. This compression often makes the lateral fins appear much wider than they really are, and sometimes even produces such a bridge between the anterior and posterior fins as is attributed to Krohn's species *lyra* * (fig. 9).

The lateral shrinkage or dorso-ventral compression made the identification so troublesome that, for the benefit of future workers, I have drawn four states of *furcata*, of which I take fig. 8 to be the normal.

Distribution.—The general table of Chætognaths and the figures immediately to be given clearly indicate that this is an epiplanktonic species. The following table is an analysis † of the captures with open nets:—

	fathoms, it occurred in	per cent. of hauls, with	average specimens per hour haul.
At 0	37	1·8	
25	16	0·3	
50	84	7·8	
75	100	16·8	
100	100	26·9	
150	1	3·0	
200	2	1·5	
250	2	2·0	
300	1	1·5	
350	1	4·5	

It occurred also in the closing-nets:—

150–50 fathoms, average specimens 13·0;
200–100 fathoms, average specimens 1·4;

but was not captured below the last zone ‡. From the above facts it is fairly apparent that the species is distributed from the surface to 100 fathoms, with a maximum distribution between 75 and 100 fathoms, a few specimens living between 200 and 100 fathoms.

* It is quite possible that the name *lyra* was given to some other species compressed in this fashion: if one may judge from the general description and from the number of teeth and jaws, Krohn very likely had *furcata* before him.

† See note, p. 60.

‡ Unless the specimens mentioned under iii. (p. 74) are really *furcata*.

The occurrences at 0 and 25 fathoms were so few that no indication of any reaction to time of day, light, or rain could be expected, even if such reaction existed. At 50 fathoms and down to 100 the specimens are so closely massed that we may regard the captures at 25 and 0 as stragglers from the main body, just as those between 200 and 100 fathoms.

SAGITTA MACROCEPHALA, sp. n. (Pl. 5. figs. 16–21.)

This species, coming only from considerable depths, presented but few specimens in sufficiently good condition for accurate description. The following points, however, will serve for diagnosis until better specimens are recorded by other observers.

Characters.—Head very large, forming when fully expanded a truncated triangle. Neck narrow and without a "collarette." Body slender, firm, but much thicker in the middle than anteriorly; lateral fields not large. Tail-segment about one-third or more of the total length; tip of tail generally bluntly conical.

Anterior fins small and (?) rounded; posterior fins larger, rounded rather than triangular, about equally divided between trunk and tail; tail-fin often pointed posteriorly.

Jaws curved throughout their whole length, sharply so in the distal fourth. Teeth very dark in colour, borne on an unusually stout bar. Teeth of the anterior row long and slender, slightly curved inwards to the middle line, their bases touching, but in complete expansion of the head they project radially outwards as a half-circlet. Teeth of the posterior row very numerous, closely set, long, and slender; in complete expansion of the head they form a curve which goes completely from the dorsal to the ventral surface, so that the dorsalmost point outwards, the ventralmost inwards.

Corona ciliata not observed. Vestibular ridge covered with a thick cuticle; it extends externally for the whole length of the row of posterior teeth, internally somewhat further, and carries irregular prominences fewer in number than the teeth.

Body sometimes salmon-pink, sometimes colourless. As the generative organs were quite rudimentary in even the largest specimens, it is probable that only immature specimens were captured.

The great size of the head and the large number of teeth, compared with the size of the body, mark this species off from all others hitherto recorded.

The following table * covers all measurable specimens captured; where the percentage of the tail is not given, the total length must be taken as only an approximation.

Distribution.—The vertical distribution of this species is conspicuously shown in the table p. 84, and the diagram Pl. 7. It occurred in 63 per cent. of the 19 hauls which closed at or below 400 fathoms; the only other certain captures were in deep hauls open from 1250 fathoms to the surface (27 *a*, 27 *a'*). Six very small specimens from 32 *l*, 35 *k*, and 36 *l* may be larvæ of this species (*macrocephala*). It failed entirely in the

* The six specimens below the transverse line in the table include all the specimens from 32 *l*, 35 *k*, 36 *l*—that is, all the shallower occurrences. I think that they are larval *macrocephala*, but they are very small and the number of posterior teeth drops rather suddenly. They are included in the curve *macrocephala* on Pl. 7.

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
18·0	28	11	8–9	27
18·0	33	10–11	5–7	25–29
17·0	32	9	5–6	32
16·5	33	10	8	27–28
16·0	..	11	8	31
15·5	32	11	8	33
15·0	36	11	7	26–27
15·0	33	11–12	7	23–24
15·0	33	11	8	29–32
13·0	..	12	8	25
13·0	..	10–11	9	27–30
13·0	34	11	7–9	23–24
12·0	..	9–11	7–10	28–29
12·0	..	10	8	27
12·0	33	9–10	7	21
12·0	37	10	7	21
11·5	30	11–12	9	21–23
11·0	31	9	7	21
11·0	36	10	6	20
10·5	38	11	9	27
10·5	33	..	5	21
10·0	..	11	8	21–22
10·0	35	10–11	9	22–23
10·0	35	10–11	6	17–20
10·0	40	11	6	18–20
10·0	33	12	7	22–23
9·0	..	11	5–6	14–16
9·0	33	9	10	20
9·0	33	11	6	19
9·0	38	10	6	17–18
9·0	33	11	7	19
8·0	43	9–10	6	15
7·0	..	10	5	12–13
7·0	35	9–11	5–6	14–15
7·0	..	10–11	3	6–7
6·5	38	10	7	5–7
6·0	41	9–10	4–5	10–11
5·0	..	9	3	5
5·0	..	10	4	7–8
5·0	40	11	4	8

15 hauls which closed between 300 and 50 fathoms, and in every haul with an open net in which the greatest depth touched was less than 350 fathoms. *S. macrocephala* was therefore undoubtedly mesoplanktonic.

Sagitta zetesios, sp. n. (Pl. 5. figs. 22–27.)

Characters.—Head proportionately of medium size, larger than the body immediately behind it, thus exhibiting a marked neck. Body fairly stout (stouter than *bipunctata*), tapering from the middle gradually towards each end; a collarette present; lateral fields rather narrow, longitudinal muscles well developed; tail 25 to 33 per cent. of the total length.

Posterior fin triangular, slightly more on the body than on the tail, its widest part at or slightly in front of the septum, not extending backwards to the vesiculæ seminales. Anterior fin well separated from the posterior, longer and narrower than the posterior, wider behind than in front, not quite or only just reaching the hinder end of the ventral ganglion. Tail-fin truncate.

Jaws very slender and strongly curved.

Teeth very long and slender, light-coloured (unlike *macrocephala*); the anterior teeth increasing in size ventrally; the posterior teeth at first increasing in length inwards, then decreasing again in the few innermost.

Vestibular ridge well developed, but covered by a thin cuticle only, very slightly mammillated by numerous small and irregular prominences, not extending for the whole length of the row of posterior teeth.

Corona ciliata not observed.

This is a fairly well-marked species. The large numbers of posterior teeth are enough to separate it from all but *serratodentata*, *bipunctata*, *Bedoti*, *hispida*, and *elegans*. From *serratodentata* the absence of serration on the jaws is enough to distinguish it. As compared with *bipunctata*, the head is larger, the body stouter, the lateral fins wider, the teeth very much longer. *Bedoti* (Béraneck), of which I have specimens from the 'Siboga' Expedition, has a much slenderer outline, and *zetesios* may be distinguished readily by the larger number of jaws and smaller numbers of anterior and posterior teeth in specimens of the same size. *S. elegans* (Verrill) has been insufficiently described and figured, so that it is not easy to point to salient characters for differentiation; but at least the proportion of the tail-segment to the total length and the number of jaws are easily checked. *S. hispida* (Conant) has a quite different form: the absence of a neck, the length and shape of the posterior fins, and the slender body all mark it off from *zetesios*, though the numbers of jaws and teeth are almost identical.

The following table has been summarized from 38 specimens. The smallest specimen, 8 mm. long, is possibly referable to some other species.

The specimen of 32 mm., which is at the head of the table, is represented in fig. 23. I have no doubt that it really belongs to this species, but that some curious action of the preserving-fluid has swelled out the epidermis in front of the anterior fin in a way which is common in my specimens of *furcata* and some other species. This was the only specimen in which the vesiculæ seminales projected noticeably. The vestibular

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
32	25	8	8	15–17
21	33	8	9	15–18
20	25–28	8–10	7–9	17–19
19	26–28	8	7–8	15–18
18	27	9	6	16
17	29	9	9	18
16	26	9	6–7	15
15	30	8	6–7	13–14
13	26–30	8–10	5–7	11–14
12	25–29	8–9	5–6	11–14
11	27–31	8–9	5–6	11–12
10	25–33	9	4–6	9–12
9	27–33	8–9	4–6	8–12
8	25	8	4	5–6

ridge was slightly more mammillated than in other specimens, in all other respects it agreed with the characters of the species as given above.

The vertical distribution of *zetesios* agrees in its general features with that of *hamata*; and as both the occasions of capture and the specimens were less numerous in this than in the latter case, it is fortunate that they thus receive corroboration. It failed at all depths less than 100 fathoms, and occurred at all depths, though sparingly, between 1000 and 100 fathoms.

The table following seems to show that, as in *hamata*, only small specimens are found near the upper limits of its distribution, the larger specimens are only found deeper.

	Specimens.	Length.		
		Max.	Min.	Average.
I. Open nets lowered to 100 fathoms	5	11	9	10
II. ,, ,, 150, 200, 250 fathoms ..	41	15	8	11
III. ,, ,, 300, 350 fathoms .... } Closing-net ,, 300–200 fathoms .... }	15	20	8	12
IV. Closing-net, various depths between 1000 and 300 fathoms ..... }	7	32	13	19

Sagitta bipunctata, Quoy & Gaimard. (Pl. 5. figs. 28–31.)

Characters.—Head small; body slender, the middle third nearly of the same thickness throughout, tapering slightly towards the head, more sharply towards the tail. Body when preserved firm, not flabby. Longitudinal muscles broad, but not stout; lateral fields of medium development; the sides of the body often shrinking inwards in preserved material, so as nearly to conceal the anterior fins. Tail very slender. Posterior fins fairly long, more on the body than on the tail, widest nearly opposite the septum; shorter than in *serratodentata*, and not extending backwards nearly to the vesiculæ seminales. Anterior fins well separated from the posterior, very narrow, not reaching to the ventral ganglion, shorter and narrower than the posterior. Tail-fin rounded posteriorly.

Jaws strong, sharply curved in the distal half. Teeth broad below, closely apposed, rather short and stumpy. Vestibular ridge with very slight prominences, about the same length as the posterior row, projecting markedly at its external end *.

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
20·0	22	10	5	13
19·5	25	10	4	18
18·0	22–25	9–10	6–7	13–17
16·0	21	10	5	15
14·0	21	9	5	14
13·0	23	9–10	5	10–12
12·0	25	9	5	12
11·0	22	9	5	8
10·0	20	8	4	8
9·0	22	9	5	10

A curious feature of the collection was the scarcity of this species, although, if the determinations of some earlier observers are to be trusted, a plentiful supply might have been expected. The explanation is probably correctly given by Steinhaus † in saying that this "ist keine rein pelagische Form, ihr Vorkommen beschränkt sich auf die Küsten. Wenn sie trotzdem auf hoher See vereinzelt angetroffen wurde, so ist dies wohl dadurch zu erklären, dass sie mit der Strömung so weit vom Lande abgetrieben ist."

On the other hand, during the homeward voyage, a haul in about 40 fathoms on

* Only traces of the corona were retained in my specimens. A good figure is given by Hertwig, Jen. Zeitschrift, 1880, pl. iv. fig. 20.

† *Op. cit. supra*, p. 28.

Parsons Bank at the entrance to the Channel produced such hundreds of *bipunctata* that the contents of the bottle looked more like vermicelli soup than the results of a tow-net.

The captures in the Bay of Biscay were only six in number (seven specimens in all), and all occurred at less than 200 fathoms in open nets; the hauls were 25 *g* (50–0); 33 *h* (75–0); 32 *d*, 32 *i*, 32 *p* (100–0); 36 *g* (200–0). From the Parsons Bank specimens I have deduced the preceding table, and have given a definition and figures to bring the species into line with the others here described.

SAGITTA DECIPIENS, sp. n. (Pl. 5. figs. 32–35.)

Characters.—Head and body of the proportions of *bipunctata* or *serratodentata*, to both of which it bears a strong resemblance; it carries, however, large ova at a very much smaller size. Body very slender, thickest behind the middle of its length, tapering very gradually towards each end. Neck not well marked; collarette very slight. The whole body very transparent, but firm, and retaining its shape. Anterior fin long and narrow, not reaching to the ventral ganglion. Posterior fin about the same length, broader, more triangular; about equally on trunk and tail, widest part at or just behind the septum. Tail-fin truncate. Corona not observed; ventral ganglion prominent. Ovary short and thick, very opaque in the transparent body, extending when apparently ripe as far as the anterior end of the posterior fin. Ova comparatively very large.

Jaws curved slightly, slender; external pillar small or absent. Posterior teeth long and closely apposed; anterior teeth shorter, triangular, with broad bases. Vestibular ridge prominent, with thick cuticle; a very strong process, sometimes forked, at the external edge, extending further at both ends than the row of teeth.

The following table has been summarized from 20 specimens.

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
11·5	30	5–6	6–7	15
10·5	28	6	7–8	15–16
10·0	25–30	5–6	6–9	14–17
9·5	31	6	6–7	13–15
9·0	33	5–6	5–10	12–18
8·0	30–37	5–6	8–9	13–16
7·5	40	6	8	14
6	....	6	9	16

Distribution.—As regards the distribution of this form, the occurrences as recorded in the general table, although correct so far as they go, must not be taken necessarily to indicate the extremes of its habitat upwards or downwards; this follows from its small

size, which makes the separation of young specimens from young of *serratodentata* and similar forms extremely difficult. The table at least yields *positive* information of its occurrence as high as 100 fathoms or less, between 150 and 50, and between 200 and 100 fathoms. Below the latter zone it failed in the closing-net, and probably does not exist. But it may have reached a higher level than 100, for in three hauls in the open nets at 75 and 50 fathoms I took young specimens which I cannot satisfactorily identify.

The foregoing species were for the most part abundant and well-characterized. But there remain a few specimens to which I dare not give a definite name, for want of sufficient material. As they may help to extend the observations of some future worker, I append a few notes on them.

SAGITTA sp. indet. ? juv.

In open nets lowered to depths between 50 and 250 fathoms, and in one closing-net (200–100), there occurred a number of small and immature specimens of a very slender type, which I dare not assign to any species. Their figures, when summarized, are as follows:—

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
9	27–33	6–7	5–6	8–11
8	25–31	6–7	4–6	8–9
7	28	7	4–5	8–9

They occurred in the following hauls:—

25 *e*	35 *e*	36 *g*	36 *i*
35 *b*	35 *m*	36 *h*	36 *k*
35 *d*	36 *e*		

They resembled young *serratodentata*, but showed neither the characteristic hooks nor serrations of the jaws. They bore a still stronger resemblance to *decipiens*, but the posterior teeth seemed hardly numerous enough for that species. They might be young *decipiens*, or *zetesios*, or possibly a separate species, but they are almost certainly not young *furcata* or *macrocephala*.

SAGITTA ? PLANCTONIS, Steinhaus. (Pl. 6. figs. 36–40.)

Under this head I rank three well-preserved specimens of doubtful relation. They bear a close general resemblance to *zetesios*, but differ in that the anterior and posterior fins are nearer together, the anterior fins reach further forward (in one to the end, in two to the middle of the ventral ganglion), the widest part of the posterior fin is

level with or behind the septum, the posterior fin is rather more on the trunk than on the tail; the teeth are shorter and thicker, and less closely appressed together; the numbers of posterior teeth are much smaller for the length.

In general characters and in the numbers of the armature they stand closest to *planctonis*, Steinhaus, except for the fact that the anterior fin is rather wider posteriorly and a slight collarette is present: of the detailed characters of the jaws and teeth in *planctonis* we have no information.

	Haul.	Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
? *planctonis*.	35 *n*	22	25	8	6–7	9–10
	21 *o*.....	16	25	9	4	7
	24 *e*.....	14	28	8	4–5	7
Species with similar armature.	*planctonis*, Steinhaus		25	8	5–6	up to 12
	furcata, Steinhaus		20	7–10	6	8
	bipunctata, Quoy et Gaimard		25	8–10	4–8	10–15
	neglecta, Aida[1]		25	8	4–5	10–12
	regularis, Aida		30	7	2–4	5–7
	hispida, Conant		25–33	7–9	4–8	8–17
	flaccida, Conant		16	8–9	7–8	10–12
	tenuis, Conant		25	7–8	4–5	7–10
	elegans, Verrill		20	8–12	5–7	12–15
	pulchra, Doncaster		16	6	6	±10

[1] Aida's *neglecta* is almost certainly *bipunctata*, Quoy et Gaim., and his *bipunctata* = *Bedoti*, Béraneck.

It is not worth while to enter into detailed differences between all these species * and my specimens, but the following rough points will serve to differentiate them:—They are stronger in build (*i. e.* stronger longitudinal muscles and smaller lateral fields) than *furcata*, much broader and less pin-shaped than *bipunctata*. The description and figure of *neglecta* are so generalised and give so little detail that it is impossible to say whether this, if a "good" species, has any relation to our specimens. From *regularis* they are readily differentiated by general outline (*cf.* Aida's fig. 17). They are too stoutly built

* It is hard to believe that all the above are separate species. It is even harder to reduce their number, since most of them are quite insufficiently described, and the figures (when they exist) are generally as inadequate as the descriptions.

to be *flaccida* or *tenuis*, and the general outline is quite different from that of *hispida*. *Elegans* is said to be very much like *bipunctata*, which cannot be said of these specimens. The limitation of the corona ciliata to the body sufficiently separates it from *pulchra*.

There remains a certain number of specimens with more or less hexapterine numbers of jaws and teeth, and of the pliant flabby hexapterine type and proportions. These may include more than one species, but the examples are either so few or so badly preserved that, not having handled as yet large numbers of undoubted *hexaptera*, I prefer to leave them somewhat vague. So far as the numbers of teeth and jaws are concerned, most of them can be fitted only into *hexaptera* (d'Orb.), *magna* (Langerhans), or *tricuspidata* (Kent). Dr. Krumbach has already expressed his belief that *hexaptera* and *magna* are synonyms: with this I agree (so far as is allowable without a comparison of type specimens), at any rate as regards the *magna* of Langerhans; whether Grassi had the same species before him, or not, is hard to say. I incline further to add *tricuspidata* as yet another synonym, having before me large specimens from the 'Siboga' expedition, which by the numbers of the armature are *tricuspidata*, but in other respects agree sufficiently with *hexaptera*. Kent's original diagnosis of *tricuspidata* was not adequate: except for the armature numbers, it might be applied to several species, and his figure might stand for an inflated *hexaptera*; it has certainly a more apoplectic look than most *hexaptera*, but the proportions of the body alter at death in very different directions among these less rigid forms, and I have noted a greater difference in general form between two specimens of *furcata* than exists between Kent's figure of *tricuspidata* and the ordinary drawings of *hexaptera*.

(i.) A few of these specimens are probably attributable to *Sagitta*? *hexaptera*, d'Orbigny, itself. They occurred as follows:—

Haul.	Length in mm.	Tail as p.c. of total length.	Jaws.	Anterior teeth.	Posterior teeth.
25 *k*	14	21	7	3	3
26 *c*.....	11	22	7	3	2
32 *k*	36	25	6 7	4	4

Species indeterminatæ.

(ii.) From several hauls came specimens of which the cirrhi were either in excess of those recorded for *hexaptera*, or were present in very small specimens to the number of eight, the maximum number in the largest *hexaptera* as yet recorded (if Grassi's *magna* be omitted). Some of these were probably young *furcata*, others may be the young of other species.

They may be summarized as follows:—

Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
22	26	10	5	5
20	22	8	5	3
19	21–26	8–10	3–4	4
15	26–31	9	3	2–4
13	23	8	3	4
12	25–33	9–11	3–4	2–3
10	25	8	2	3
9	27–33	8–11	2–4	2–4

They occurred sparingly between 50 and 500 fathoms.

(iii.) Three large specimens of hexapterine appearance, much compressed, will probably be easily identified by any future observer who takes this species, from the remarkable character of the most dorsal (youngest) jaws (Pl. 6. fig. 41).

These specimens came from 500 and 250 fathoms.

Haul.	Length in mm.	Tail as p.c. of length.	Jaws.	Anterior teeth.	Posterior teeth.
29 *a*	33	17	6	7–8	8
29 *a*	29	20	7	4–5	8
21 *m*	28	18	3	7	3

The last specimen had certainly lost some jaws, of which the sockets were to be seen, and probably some posterior teeth. They might possibly be *furcata*, dead and sinking, for the younger jaws in this species resemble those figured in form, but are less strong: against this was the length and sharpness of the teeth, nor did the fins exactly resemble those of *furcata*.

Krohnia hamata, Moebius. (Pl. 6. figs. 42–46.)

Characters.—Head small; body slender, resembling *bipunctata*, firm, retaining its shape (except when considerably damaged), thickest in the middle third, tapering gradually to both ends; neck fairly well marked; no collarette. Lateral fins long, not extending posteriorly nearly to the vesiculæ seminales, but beginning only a little way behind the septum; widest point at or just in front of the septum; fin-rays extending about as far in front of the septum as the fin does behind it, but the fin continued

forwards * as an expansion of the epidermis up to or to the middle of the ventral ganglion. Tail-fin truncate.

Jaws slender, not strongly curved, the tips bent through nearly 90° into a hook †. Teeth broad below: in old specimens very closely set, long, and sharp. Corona ciliata not observed ‡.

Distribution.—Some years ago, in a most instructive paper, Prof. Chun § discussed the known occurrences of this species, and utilised them to illustrate the theory that the alleged similarity between the epiplankton of subarctic and subantarctic || regions might be explained by these two cold-water faunas being really continuous by way of the cold deep water of the main oceans.

According to the theory, *hamata*, an essentially cold-water form, should at low latitudes (high upper temperatures) fail in the epiplankton, but be captured in the mesoplankton.

In my Faeroe Channel cruises, *hamata* was fairly plentiful in the epiplankton, but occurred with even greater regularity in the mesoplankton; apparently like some other supposed subarctic forms, it showed even at that latitude a preference for the deep cold water, water which in that area was purely of arctic origin.

It is, therefore, very interesting to find that, even as far north as our positions during the 1900 cruise, it failed altogether in hauls at the surface or 25 fathoms; it appeared once only at 50 fathoms ¶, twice at 75 fathoms, but regularly at deeper horizons down to 2000 fathoms.

At	0	fathoms	it occurred	in	0	out of	25	hauls	= 0 per cent.
„	25	„	„		0	„	12	„	= 0 „
„	50	„	„		1	„	13	„	= 7 „
„	75	„	„		2	„	11	„	=18 „
„	100	„	„		14	„	22	„	=63 „
„	1000 to 100	„	„		22	„	30	„	=73 „
„	2000 to 1000	„	„		1	„	7	„	=14 „

This table shows clearly that while odd specimens (and, as a matter of fact, tiny specimens) may range exceptionally as high as 50 fathoms, it is between 2000 and 100 fathoms that this species is to be sought. Below 1000 fathoms it was only captured

* This is so constant in apparently perfectly preserved specimens that I have no doubt that it is a normal structure.

† This is less marked in the older (ventral) teeth of old specimens, probably the result of wear.

‡ Figured by Strodtman, Arch. Naturgeschichte, 1892, pl. xvii. fig. 18.

§ C. Chun, 'Beziehungen zwischen dem arktischen und antarktischen Plankton,' Stuttgart, 1897.

|| In the discussion of this alleged "Bipolarity," the issue has been obscured to some extent by loosely terming the regions under discussion "arctic" (Labrador, Greenland, Iceland, N. Norway, &c.) and "antarctic" (Patagonia, S. Georgia, the Kerguelen area, &c.). These regions are more correctly classed by temperature as subarctic and subantarctic: between the faunas of truly arctic and antarctic regions, with a permanent sea temperature of 0° C. or thereabouts, no real resemblance has been shown.

¶ This haul, 25 *e*, is under suspicion: it may be a portion of 25 *d*, 100 to 0.

once by the closing tow-net, but large specimens were also captured by the closing trawl between 2000–1000 and 1500–750 fathoms. The species, then, in this area is mesoplanktonic, and certainly ranges as deep as to the zone 2000–1500, probably to deeper water still.

The captures, however, enable another point to be made, namely:—that older (larger) specimens do not frequent even the upper zones of the mesoplankton, but the deeper strata only. Specimens more than 17 mm. in length—and this is small for *hamata*—were met with only below 500 fathoms.

	Horizon in fathoms.	Number of specimens measured.	Maximum length in mm.	Average length in mm.
Open tow-nets	0			
	25			
	50	2	11·0	10·0
	75	4	13·0	10·3
	100	98	13·5	10·5
	150	27	15·0	11·9
	200	11	13·0	11·4
	250	139	15·5	13·9
	300	53	17·0	13·6
	350	38	16·0	12·7
Closing tow-net	500 to 100	28	17·0	11·8
	750 to 500	16	27·0	18·8
	1000 to 750	11	28·0	21·3
	2000 to 1000	1	....	20·0
Closing trawl	1500 to 750	1	....	33·0
	2000 to 1000	1	....	23·0

We may fairly conclude from this table that in the area studied the older specimens are to be found in the deeper strata of the mesoplankton only, though the young forms may frequent higher levels. Only small specimens occurred above 500 fathoms, large specimens only below 500, but small specimens also occasionally occur below 500.

This touches a question of great interest, at which, so far as I know, no connected work has been done. The young of epibenthic and epiplanktonic forms mostly spend an early or larval life at the surface: where do deep-water oviparous forms, whether plankton or benthos, spend their early life? Do they similarly seek higher levels? and,

if so, do they range also to the surface? The answer for *hamata* appears to be, that they rise higher, but stop short of the surface; *zetesios* apparently follows the same habit. Of course where, as in the subarctic region, the species is epiplanktonic, the young are also epiplanktonic.

The materials are now to hand for a fairly complete idea of the distribution of *K. hamata* in the Atlantic. As an epiplanktonic and mesoplanktonic form it ranges from 81° N. (Römer and Schaudinn) over the North Atlantic, from Greenland and the Labrador Current in the west to Spitzbergen and Lofoten in the east, occasional drifted specimens reaching along the Norwegian coast into the Baltic. In the Faeroe Channel with comparatively high surface-isotherms, it shows a preference for the mesoplankton, although also occurring less plentifully in the epiplankton *. Passing southwards—in the Bay of Biscay it was purely mesoplanktonic. In the South Equatorial Current the same holds good; only young specimens were obtained by the 'National,' and only by the closing-net at considerable depths †. Still further south, young specimens were obtained from a depth not greater than 38 fathoms, at 40° S., by Dr. Schott and Captain Bruhn ‡; in other words, the species rises nearer to the surface at high latitudes with a lower and more suitable surface isotherm. Lastly, I am glad to be able to complete the series by a well-preserved and unmistakable specimen captured at or close to the surface by my friend Mr. Vallentin at the Falkland Islands, well within a subantarctic district.

KROHNIA HAMATA, Moebius, var. (Pl. 6. figs. 47–49.)

Among the *hamata* were a few specimens which could not be quite reconciled with all the characters of Moebius's species, although probably only a variety. There were two well-preserved specimens of 23 and 12 mm., the smaller serving to connect with some yet smaller larvæ. They differ from *hamata* in the possession of a stouter body, with a less marked taper, of somewhat more curved jaws which seem longer in comparison with the head; the tips of the jaws are longer and only slightly bent. Fins similar in both.

The specimen figured (30 *e*, 23 mm. long) exhibited the characters thus described; there were also heads and damaged specimens from some other hauls, of which at any rate the jaws and teeth showed the same or an intermediate variation from *hamata*. So likewise did the five small specimens in the table; these were further characterized by a ferocious-looking sagination of the jaws: a similar sagination has been described by Strodtmann in some young specimens of *hamata*, which I can confirm from Faeroe Channel material. The saginate jaws are the more ventral (older). The 12 mm. specimen seemed to suggest that the ultimately smooth outline of the jaw was attained by a filling-up of the spaces between the saw-teeth.

The occurrences of this variety have been reckoned as *hamata* in the previous calculations, in the notes on general distribution (p. 81), and in the diagram (Pl. 7).

* The observations on which this statement is based have not yet been published.

† O. Steinhaus: *op. cit. supra*, p. 34.

‡ O. Steinhaus: *op. cit. supra*, p. 47.

Haul.	Total length in mm.	Tail as p.c. of length.	Jaws.	Teeth.
30 *e*	23	26	12–13	13
26 *b*	20	25	9–10	9
21 *k*	12	25	10–11, 3 saginate.	10
36 *l*	9	27	10, 5 „	5
36 *l*	8	25	11, 6 „	4
32 *l*	7	28	9, 7 „	3–4
34 *e*	6	33	9, 8 „	2

KROHNIA SUBTILIS, Grassi. (Pl. 6. figs. 50–52.)

Characters.—Head of moderate size; body extremely long and slender, transparent, not firm and rigid like *hamata* at a corresponding length; thickest at about the middle of its length, but even here only slightly thicker than at the neck, the taper extremely gradual. Neck fairly well marked; a slight constriction at the septum. Lateral fins very long, reaching from the vesiculæ seminales to a third of the distance between

Total length in mm.	Tail as p.c. of total length.	Jaws.	Teeth.
15	36	7–8	11–12
15	40	7	12
14	35	7–8	11
14	35	7	12
14	35	8	10–11
13	30	9	11
12	33	8	13
11	36	8	9–10
9	33	6	10–11
8	37	8	7

septum and ganglion, about two-thirds on the tail and one-third on the body, widest at or in front of the septum; fin-rays present throughout its length. Tail-fin truncate, extending anteriorly to the vesiculæ seminales. Jaws strongly curved, very sharp, usually thin when viewed from the outside. Teeth similarly thin plates, bayonet shaped *. Vestibular ridge (apparently) absent; corona ciliata not observed.

* Compare Grassi, pl. i. figs. 9, 10.

I can find no distinction between this species and Aida's *pacifica* except in the corona, which in *pacifica* is confined to the trunk, and in *subtilis* extends also on to the head. As, however, it was not figured by Grassi, and is only one out of several characters, it seems fairly safe to put the two species together. The teeth are not always so numerous as Grassi's number of 18, nor does the head look large unless the cheeks are thrown out and the jaws turned in, in the death contraction.

Distribution.—This species was comparatively scarce. It failed altogether at the surface and 25 fathoms, and was taken only six times in all (13 per cent.) at 50, 75, and 100 fathoms. It failed in all the closing-nets, but appeared in hauls with open nets at 200, 250, and 300 fathoms. The only positive evidence therefore of its distribution points to its habitat being between 50 and 100 fathoms; but the species being so scarce in the locality, too much weight must not be laid upon this.

General Remarks on the Vertical Distribution *.

In handling the captures as a whole, the hauls with open tow-nets can be compared together with fair accuracy, and the hauls with the mesoplankton nets are similarly comparable amongst themselves. But while the former were lowered to a set depth, and towed horizontally at that level for a fixed time (generally an hour), the mesoplankton closing-net was opened at the lowest depth and drawn up vertically through a comparatively small quantity of water before closure †.

The mesoplankton net therefore cannot be expected to capture so many specimens as the open nets used at higher levels. At the same time the hauls were so numerous, that only rare species can have uniformly escaped.

In the following tables, therefore, all hauls which could be usefully compared have been divided between the open nets and the closing-nets.

i. Hauls with open nets.

At fathoms	hauls, occurred	specimens in	per cent. of	hauls, giving as average specimens per hour
0	169	81	16	10·5
25	52	75	12	4·3
50	239	100	13	18·3
75	241	100	11	21·9
100	881	100	22	40·0
150	21		1	21·0
200	12		1	12·0
250	101		2	50·5
300	37		1	37·0
350	33		1	33·0

* As in dealing with *serratodentata* and *furcata* above, nine hauls with a small-mouthed net and 180 meshes per linear inch have been omitted from the following calculations. The captures in all open nets have been treated with a time-factor to bring them to the standard one-hour haul. The captures by the closing-net towed through 250 fathoms have been divided by 2·5, and through 500 fathoms by 5, to bring them to the standard 100-fathom haul. 21 *n* (open for 50 fathoms only) and 21 *a* (a closing-net which arrived open at the surface, a miss-fire of the gear) have also been omitted as not being in line with the other mesoplankton hauls.

† Comparo *suprà*, p. 4.

From this table it may be inferred that Chætognaths were less plentiful (or more migratory) between 0 and 50 fathoms: that the population increased down to 100 fathoms at least. Below that level the hauls were scanty and the figures therefore are much less reliable: not only so, but it must be remembered constantly that these open nets, and especially the deeper hauls, pick up a large quantity of specimens on their upward journey which belong to shallower horizons *. The 250-fathom hauls, for example, represent not only the captures in an hour's slow horizontal towing (say a mile and half), but also those of 250 fathoms vertical towing at a greater pace— a very considerable addition. Now it is a fair inference from the above, that if the population below 100 fathoms were as large or larger than at that horizon, the average captures should number considerably more, whereas, except in one instance †, they are less than at 100 fathoms. Hence we may conclude that the population diminishes below 100 fathoms or thereabouts. This conclusion is confirmed by the more accurate method of the closing-net.

ii. Hauls with the closing-net.

	fathoms occurred	specimens in	per cent. of	hauls, giving as average specimens per 100 fathoms
Between 150–50	16	1	1	16·0
200–100	42	6	7	6·0
250–150	5	2	3	1·6
300–200	6	3	3	2·0
400–300	9	3	3	3·0
500–400	10	3	3	3·3
750–500	16·4 [1]	4	4	4·1
1000–750	11·2 [1]	3	5	2·2
1250–1000	1·2 [1]	3	3	0·4
1500–1250	0	0	2	0·0
2000–1500	1·2 [2]	1	2	0·6

[1] Number captured divided by 2·5. [2] Number captured divided by 5·0.

The sudden drop in the last column after 200 fathoms is most instructive: from 200–1000 fathoms the figures are small, but as steady as could be expected from the comparatively small number of hauls. Below 1000 fathoms is apparently another drop; but even at this deepest stratum there can be no question of the presence of quite large numbers of Chætognaths even at the lowest depth investigated; for example, the three hauls 1250 to 1000 fathoms filtered only a cube of about 16 feet each, but produced one specimen each. Haul 26 *b* (2000–1500 fathoms) was towed at about 1900 fathoms

* Of course exactly the same criticism applies to my hauls with open nets at 25, 50, 75, and 100 fathoms; but with much less force, for these hauls were only towed upwards through a small fraction of their horizontal tow (instead of a large one), and were made in such numbers as practically to eliminate error by comparison. Below 100 fathoms the ratio of vertical to horizontal tow becomes serious, unless very prolonged horizontal hauls be taken, which is bad for the material captured.

† Namely 250 fathoms. Of the two hauls concerned, the one contained considerably more (72), the other considerably less (29), than the average for 100 fathoms.

for an extra twenty minutes, as a steamer collided with us in the middle of the operation and stopped proceedings for that period; it produced five specimens belonging to two species.

In the diagram, Pl. 7, I have endeavoured to express the comparative distribution of Chætognaths as a whole at all depths, and also some points in that of the common species. (1) The lines labelled *decipiens* and *zetesios* merely record the vertical extension of these two species from positive observations (that is, closing and shallow open nets; the deep open nets being regarded as untrustworthy): they did not occur in sufficient numbers to give any indication of a centre of distribution. (2) The three diagrams marked *serratodentata*, *furcata* i., and *hamata* i. represent, as ordinates to the curves, the average number of specimens per hour haul by open nets at various depths. They seem to show that *serratodentata* is most plentiful down to 100 fathoms, *furcata* most plentiful from 50 to 150 fathoms, and that these upper *hamata* (which are all very young specimens, p. 76) are numerous between 150 and 300 fathoms *. These three diagrams are all drawn to one scale, and the ordinates to the curves are placed at the lowest or towing-depth of the net. (3) The remaining four curves deal with the closing-net, and are also all drawn to one scale. They are not to be compared with the foregoing curves, because they represent, as ordinates to the curve, the average number of specimens per 100-fathom haul of the closing-net at various depths. The ordinates in this case are placed in the centre of the zone studied: thus the ordinate for 150–50 fathoms is drawn on the 100-fathom line. The curve marked *furcata* ii. shows that the population, high at 150–50, drops suddenly between 200–100 fms.; below this zone the species was not captured in closing-nets, and presumably does not occur †. The curve marked *hamata* ii. ‡ shows clearly enough the influence of a large number of young specimens between 200–100 fathoms. Both *hamata* ii. and *macrocephala* curves seem to show a rise in population between 750 and 500 fathoms, as indicated by the ordinate on the 625-fathom line: this is of course repeated in the curve of general capture of all species. Whether this really indicates a zone of thicker life here or not, will be more easily seen when other groups have been worked out, but I certainly noticed the same rise in population when counting the Copepods in a series of typical hauls. The curve marked "all species together" is a graphic expression of the last column in the table on page 80. Unfortunately it by no means agrees with the only previous attempt to deal with the vertical distribution of Chætognaths as a whole.

Last year Mr. R. T. Günther published a paper "On the Distribution of Mid-water Chætognatha in the North Atlantic during the Month of November" (Ann. Mag. N. H. (7) xii. p. 334). Of his main general conclusions, the most important—namely, "that the upper hundred fathoms contain but few individuals as compared with the deeper

* The drop in this curve at 200 fathoms, based on a single observation, would probably have flattened out as indicated by the dotted line if more observations had been taken.

† The specimens recorded in open nets below 100 fathoms were therefore probably caught in the vertical journey upward: an instance of the deceptiveness of the method of open nets.

‡ This includes *hamata*, var., p. 77.

waters of the Atlantic"—is, to my belief, absolutely deceptive, and must be attributed to the faulty method of capture employed and to the consequently inadequate evidence laid before him. In the first place, if one may argue from his diagram *, no hauls were taken at depths between 50 and 200 fathoms. Now, as has been shown above, this includes the most populous zone in the ocean, and is well known to be so from the results of other expeditions. Apparently it was entirely passed over in these collections. In the second place, the species not having been identified, the deduction entirely neglects the fact that different species inhabit different depths. Lastly, the conclusion takes no count of the weakness of the method of serial open tow-nets at great depths—namely, that it does not eliminate the organisms captured in the upward journey at higher levels: this alone is enough to vitiate the conclusion. The effect of the upward journey through what (according to my results) are more populous zones can to some extent be gauged from the following observations:—My average specimens between 1250–1000 fathoms were 0·4; now hauls 27 *a* and 27 *a'* missed fire, and the closing-net failed to close, its contents therefore represent specimens obtained on the upward journey only. These two hauls contained no less than 39 specimens belonging to six species; ten specimens belonged to *serratodentata* and *furcata*, of which I was unable to prove the occurrence below 200 fathoms by the closing-net!

The closing-net brings comparatively little to the surface, but of this little we at least know accurately where it was caught †; and when my curve of "all species together" is compared with Mr. Günther's result, there can be little doubt that a large proportion of his specimens were caught on the upward journey.

With Mr. Günther's second conclusion—that small specimens are more plentiful at the higher levels, large specimens are more characteristic of greater depths—I am in entire agreement, although I fear we might not agree exactly as to levels. But, so far as my results go, this follows from the presence at higher levels of young specimens which seek deeper water when adult (compare pp. 68 and 76).

The only other attempts to record the vertical distribution of Chætognatha as yet have been made by Strodtmann and Steinhaus on the materials of the 'National' (German Plankton) Expedition. Unfortunately the results of the surface and horizontal hauls have not yet been published; only vertical and closing nets are available, and these only for parts of the cruise. It is, therefore, of no value at present to compare the results of the 'National' and 'Research' in detail; in so far as they overlap, they agree in the main, except in that the 'National' failed to prove the existence of Chætognaths below 1500 m. (812 fms.).

Summary of the observed Distribution.

These conclusions are stated less dogmatically in the foregoing text: a reference to

* No detailed list of the hauls on this cruise has been published. Since the above was in print, I learn through Mr. V. H. Blackman that two hauls were made between the depths mentioned.

† By disconnecting port and starboard engines, and using them separately as required, we were able to keep the wire rope straight up and down: Mr. George Murray's criticism of the uncertainty of the horizon therefore falls (Journ. R. Geog. Soc. xiii. p. 153).

the pages cited will give the necessary qualifications and the evidence. It is hardly necessary to remark that all these statements refer exactly only to the area studied and to the period of the cruise. They are not necessarily, many of them not even probably, true for distant localities under different conditions.

Sagitta serratodentata was epiplanktonic, extending from the surface to 100 fathoms, with the highest number of average specimens at about 50 fathoms (p. 59). It showed no indication of a nocturnal rise and diurnal fall (p. 60). On the contrary, although not affected during the day by the actual light-intensity of the moment, still on the whole it sought the surface by day and deserted it by night (p. 61). During or after rain it abandoned the surface even in bright daylight, the largest number of specimens being then found from 50 to 100 fathoms (p. 61).

S. furcata was also epiplanktonic, with a maximum distribution between 50 and 100 fathoms (pp. 64, 81). Occasional specimens reached the surface and 25 fathoms, but it was not taken below 200 fathoms (p. 64).

S. macrocephala was purely mesoplanktonic, ranging from 400 (?300) to 2000–1000 fathoms (pp. 65, 67).

S. zetesios was also mesoplanktonic, ranging from 100 to 1000–750 fathoms (p. 68). At less than 300 fathoms only small specimens were taken; the large specimens were all from greater depths.

S. bipunctata, being apparently a neritic form, occurred very sparingly in the epiplankton (p. 70).

S. decipiens belonged to the upper mesoplankton; it was taken with certainty only between 100 and 200 fathoms (p. 70).

Krohnia hamata was mesoplanktonic, never reaching as high as 25 fathoms, but extending to the 2000–1500-fathom zone (p. 75). Above 500 fathoms only small specimens of 5–17 mm. were found, extending into the lower epiplankton (p. 76); the length of these smaller specimens on the whole increased with the depth, and their maximum distribution was about 150–250 fathoms (pp. 76, 81). Only below 500 fathoms were large specimens to be found, mixed with a few small specimens, possibly corpses.

K. subtilis occurred only in the upper mesoplankton and lower epiplankton, in too small numbers for accurate deduction.

Chætognatha as a whole increased in numbers as one passed from the surface to 100 fathoms (p. 79), and diminished again in numbers between that level and 200 fathoms (p. 80). At about 200 fathoms there was a sudden drop in the population, which then remained fairly steady down to about 1000 fathoms (p. 80), with a possible indication of a slight increase in the 750–500-fathom zone (p. 81). Below 1000 fathoms was a second sudden drop (p. 80). Chætognaths occur, however, in considerable numbers even at the lowest zone studied, 2000–1500 fathoms (p. 80).

In the following table the first three hauls refer to the mesoplankton trawl, the remainder to tow-nets of "comparable" hauls.

Table of the Occurrence of the commoner Forms.

Depth in fathoms.	Haul.	*serratodentata.*	*furcata.*	*macrocephala.*	*zetesios.*	*decipiens.*	*hamata.*
500—250	29 *a*						
1500—750	30 *a*	..	..	..	..	..	+
2000—1000	30 *e*	..	..	..	..	..	+
0	21 *e*	+					
	21 *f*						
	21 *i*						
	22 *d*	+	+				
	22 *e*	+					
	22 *g*	+					
	23 *b*	+	+				
	23 *c*						
	23 *d*	+	+				
	23 *e*	..	+				
	24 *c*						
	24 *f*	..	+				
	24 *g*	+					
	24 *h*						
	24 *i*	+					
	24 *k*						
	25 *a*	..	+				
	25 *b*	+					
	25 *h*	+					
	25 *i*						
	25 *l*						
	30 *c*						
	32 *c*						
	33 *a*						
	33 *b*						
25—0	26 *a*	+					
	30 *b*	+					
	30 *m*	+					
	31 *a*	+					
	32 *b*						
	32 *e*	+					
	33 *e*	+	+				
	33 *g*	+					
	34 *a*						
	34 *g*						
	35 *w*	+					
	36 *c*	..	+				
50—0	21 *g*	+					
	25 *e*	+	..	..	..	..	+
	25 *g*	+	+				
	25 *k*	..	+				
	26 *c*	+	+				
	30 *d*	+	+				
	30 *l*	+	+				
	31 *b*	+	+				
	32 *a*	+	+				
	32 *h*	+	+				
	33 *c*	..	+				
	33 *f*	+	+				
	36 *d*	..	+				
75—0	30 *f*	+	+				
	32 *g*	+	+				
	32 *m*	+	+				
	32 *o*	+	+				
	33 *h*	..	+				
	34 *c*	..	+				
	35 *a*	+	+	..	..	..	+
	35 *c*	+	+	..	..	..	+
	35 *e*	+	+				
	35 *y*	+	+				
	36 *a*	+	+				

Depth in fathoms.	Haul.	*serratodentata.*	*furcata.*	*macrocephala.*	*zetesios.*	*decipiens.*	*hamata.*
100—0	21 *h*	+	+	..	..	..	+
	21 *l*	+	+				
	22 *a*	+	+				
	24 *b*	+	+	..	+	..	+
	24 *d*	..	+				
	24 *e*	+	+	..	+	..	+
	25 *d*	+	+	..	..	..	+
	30 *g*	+	+	..	..	+	+
	30 *h*	+	+	..	..	..	+
	32 *d*	+	+	..	..	+	+
	32 *i*	..	+	..	..	..	+
	32 *n*	+	+	..	..	+	+
	32 *p*	+	+	..	..	+	+
	33 *d*	+	+				
	34 *b*	+	+				
	34 *d*	+	+				
	35 *b*	+	+	..	..	+	+
	35 *d*	+	+	..	..	..	+
	35 *f*	+	+	..	..	..	+
	35 *x*	+	+				
	36 *b*	+	+				
	36 *e*	+	+	..	+	+	+
150—0	36 *f*	+	+	..	+	+	+
150—50	21 *p*	..	+	..	..	+	+
150—100	21 *n*	..	+				
200—0	21 *a*	+					
	36 *g*	..	+	..	+	+	+
200—100	21 *b*	+	..	..	..	..	+
	21 *o*	..	+	..	..	..	+
	26 *e*	..	..	..	..	+	
	34 *h*	..	+	..	..	..	+
	35 *m*	..	+	..	..	+	+
	35 *n*	..	+	..	..	+	+
	35 *t*						
250—0	36 *h*	..	+	..	+	+	+
	36 *i*	..	+	..	+	..	+
250—150	35 *o*	..	..	..	+	..	+
	35 *p*						
	35 *s*	..	..	..	..	..	+
300—0	36 *k*	+	+	..	+	+	+
300—200	21 *c*	..	..	..	+	..	+
	26 *f*	..	..	..	+		
	35 *l*	..	..	..	..	..	+
350—0	36 *l*	+	+	?	+	+	+
400—300	21 *k*	..	..	..	+	..	+
	32 *l*	..	..	?	..	..	+
	35 *k*	..	..	?			
500—400	21 *m*	..	..	+	+	..	+
	35 *h*	..	..	..	..	..	+
	35 *i*	..	..	+	..	..	+
750—500	22 *b*	..	..	+	..	..	+
	30 *k*	..	..	+	..	..	+
	34 *e*	..	..	+	+	..	+
	34 *f*	..	..	+	+	..	+
1000—750	23 *a*	..	..	+	..	..	+
	27 *c*						
	31 *d*	..	..	+	..	..	+
	32 *f*						
	32 *k*	..	..	+	+	..	+
1250—1000	24 *a*	..	..	..	?		
	27 *b*	..	..	+			
	31 *c*	..	..	+			
1500—1250	25 *f*						
	30 *i*						
2000—1500	25 *c*						
	26 *b*	..	..	+	..	..	+

APPENDIX.

CHÆTOGNATHA FROM THE FALKLAND ISLANDS.

My friend Mr. Vallentin was kind enough to send me six specimens which he collected at Port Stanley in 1896. They included only two species.

Krohnia hamata, Moebius.

A well-preserved specimen of this interesting species has been already mentioned (p. 77) as completing the chain of occurrences required by Chun's theory of the continuity of the subarctic and subantarctic Plankton through the tropical Mesoplankton. The specimen, from between the surface and 6 fathoms, was about 18 mm. long, with at least 8 jaws and 11 teeth; the exact numbers could not be given without damaging the specimen, as both jaws and teeth were turned strongly inwards in contraction.

Sagitta serratodentata, Krohn.

There were five specimens, from the surface to 6 fathoms, quite indistinguishable from the Biscayan specimens and agreeing with them in numbers.

Length. mm.	Tail as p.c. of total length.	Jaws.	Anterior teeth.	Posterior teeth.
9	33	6	2–3	3
15	26	7	8	7–8

This species has already been recorded from the subantarctic region, obtained by the Hamb. Magalhaens. Expedition (Steinhaus).

Literature.

A list of the literature of Chætognatha was published by Strodtmann :—"Die Systematik der Chætognathen," Archiv für Naturgeschichte, lviii. p. 333. This was supplemented by Steinhaus, 'Die Verbreitung der Chætognathen im südatlantischen und indischen Ozean,' Inaug. Diss. Kiel, 1896. Since then the following papers on the system of Chætognatha have appeared :—

T. Aida.—"Chætognaths of Misaki Harbour." Annot. Zool. Japon. i. p. 13 (1897).

L. Doncaster.—"Chætognatha." Fauna and Geog. Maldive and Laccadive Archipelagoes, i. p. 209.

T. Krumbach.—"Ueber d. Greifhaken d. Chätognathen." Zool. Jahrb. (Abth. Syst. &c.) xviii. p. 579 (1903).

O. Steinhaus.—"Chætognathen," in Hamburg. Magalhaens. Sammelreise, Lief. v. (1900).

EXPLANATION OF THE PLATES.

Plate 4.

Fig. 1. *Sagitta serratodentata.* ×7.
2. A jaw. ×105.
3. Tips of two jaws. ×430.
4. Teeth of the left side, from the ventral surface. ×210.
5. Vestibular ridge of the left side, from the ventral surface. The tips only of the posterior teeth are shown. ×210.
6. Dorsal view of the anterior end, showing the corona ciliata. ×24.

Fig. 7. *Sagitta furcata,* Steinhaus. Very well preserved, except for a shrinkage inwards of the lateral fields, which carries the anterior fins nearly out of sight. ×3·5.
8. The same, perfectly preserved, representing the supposed living outline. ×3·5.
9. The same, badly preserved and dorso-ventrally compressed : the epidermis in the posterior two-thirds flattened and loosened, making the fins appear too broad, and forming a *lyra*-like bridge between the lateral fins. ×3·5.
10. The same, very badly preserved, violently contracted antero-posteriorly and somewhat compressed dorso-ventrally. The epidermis very greatly flattened and corrugated. ×6.
11. Corona ciliata and eyes. ×60.
12. A jaw. ×60.
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14. Vestibular ridge, ventral view. ×106.
15. Vestibular ridge, anterior view with teeth in place. ×106.

Plate 5.

Fig. 16. *Sagitta macrocephala,* sp. n. ×9.
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18. The vestibular ridge and posterior teeth of the left side, from the ventral aspect. ×105.
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33. A jaw. × 140.
34. Anterior and posterior teeth of left side, nearly from the anterior aspect. × 210.
35. Vestibular ridge, showing position of first and last tooth. × 210. The strong cone on the external surface is not always so well developed.

Plate 6.

Fig. 36. *Sagitta ? planctonis*, Steinhaus. × 6.
37. Dorsal view, showing relation of corona ciliata to head and to ventral ganglion, patches of sense-cells, "neck-fin," &c. × 17.
38. Vestibular ridge of left side, ventral view. × 140.
39. Anterior teeth of right side, *in situ*. × 140.
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Fig. 42. *Krohnia hamata*, Moebius. × 4.
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44. Tip of a jaw. × 520.
45. The teeth. × 210.
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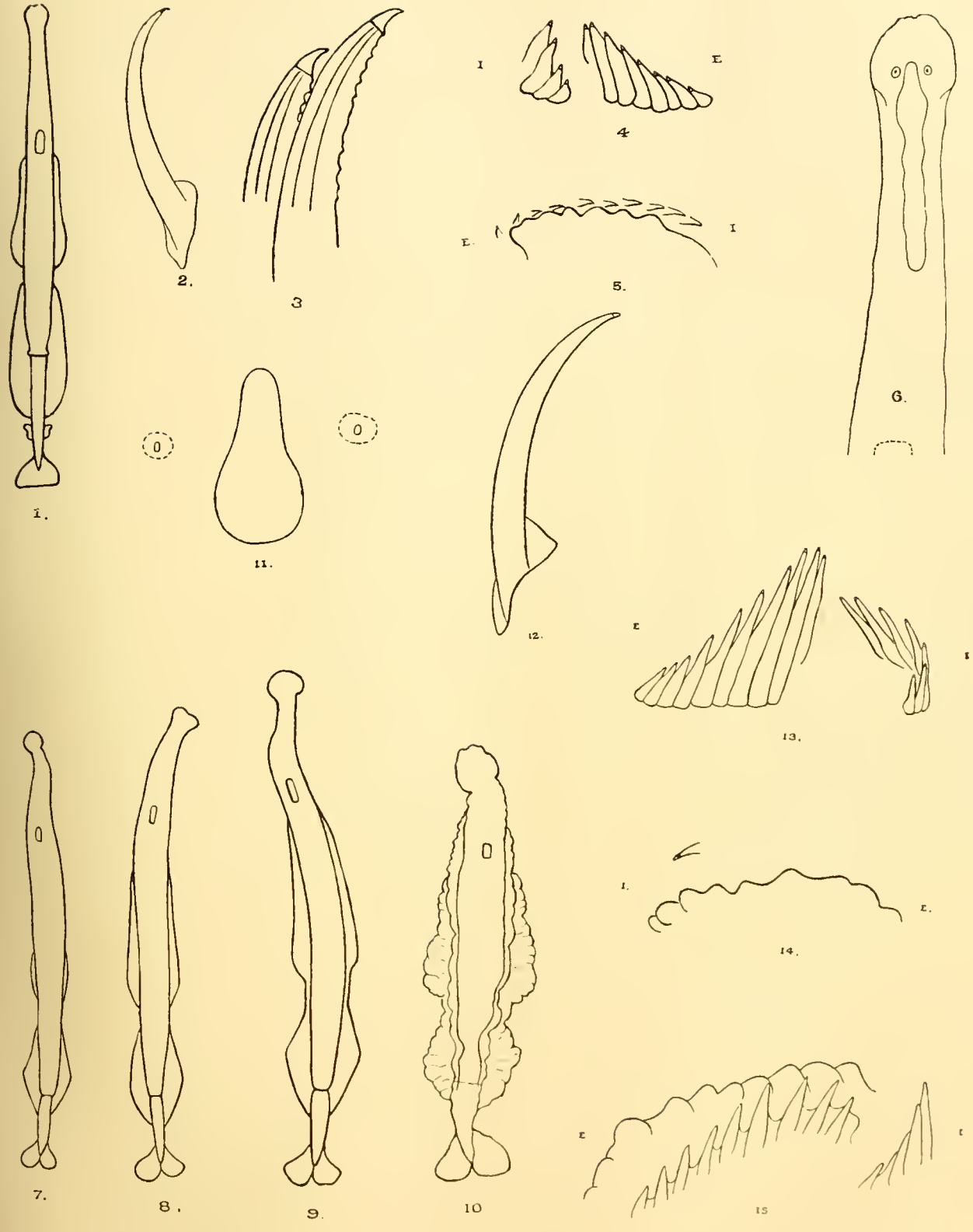
Fig. 47. *Krohnia hamata*, var. × 4.
48. Tip of a jaw. × 290.
49. Saginate jaw of young specimen. × 290.
Fig. 50. *Krohnia subtilis*, Grassi. × 4.
51. A jaw. × 106.
52. The teeth, drawn in place. × 210.

All figures have been drawn with the Abbé camera. The letters E and I indicate respectively the external and internal aspects of the teeth, the vestibular ridge, &c.

Plate 7.

Table of frequency of species of Chætognatha according to depth.



G. H. Fowler del.

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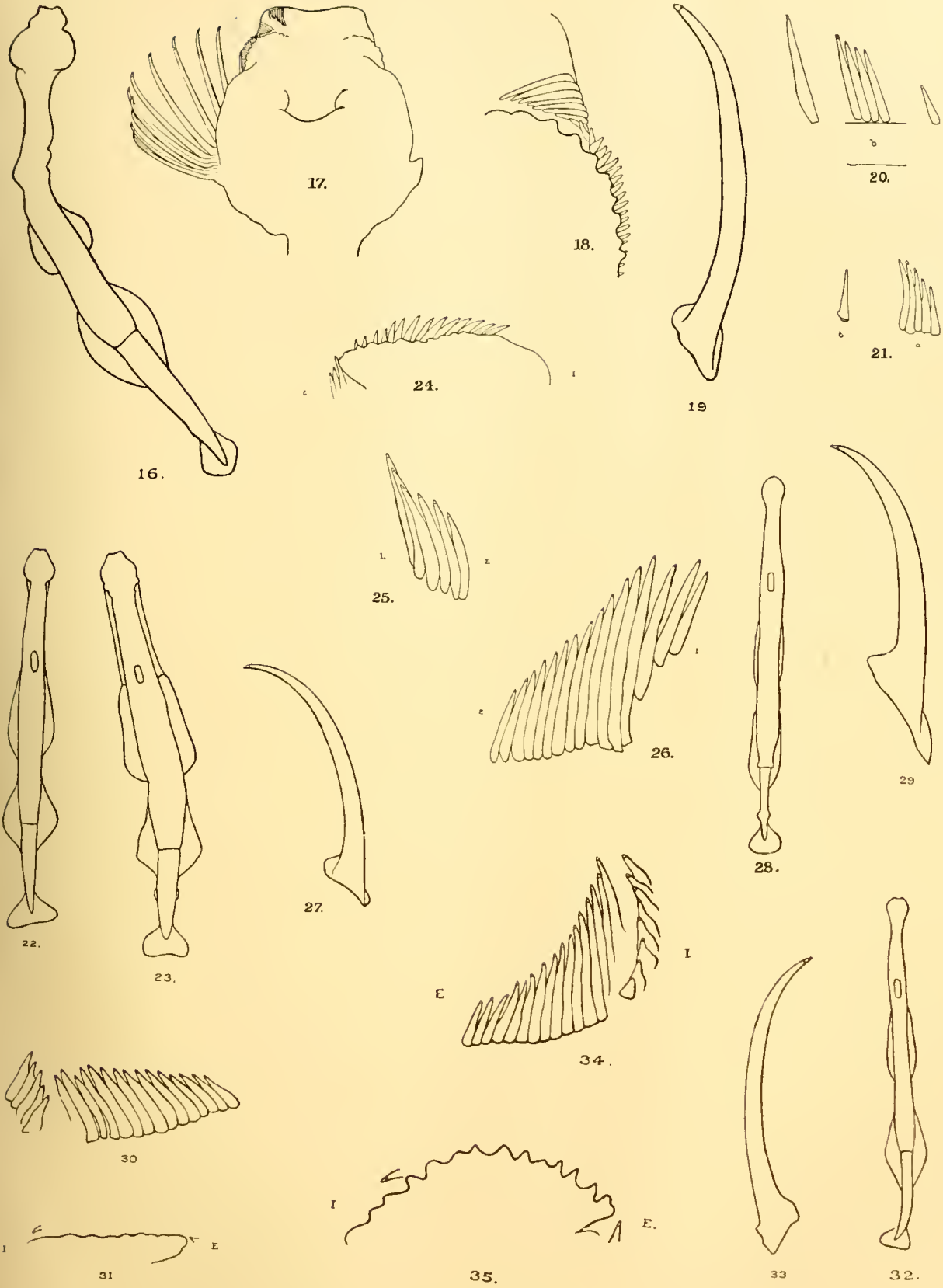
BISCAYAN CHÆTOGNATHA.

Figs. 1–6. *Sagitta serratodentata*; 7–15. *Sagitta furcata*.



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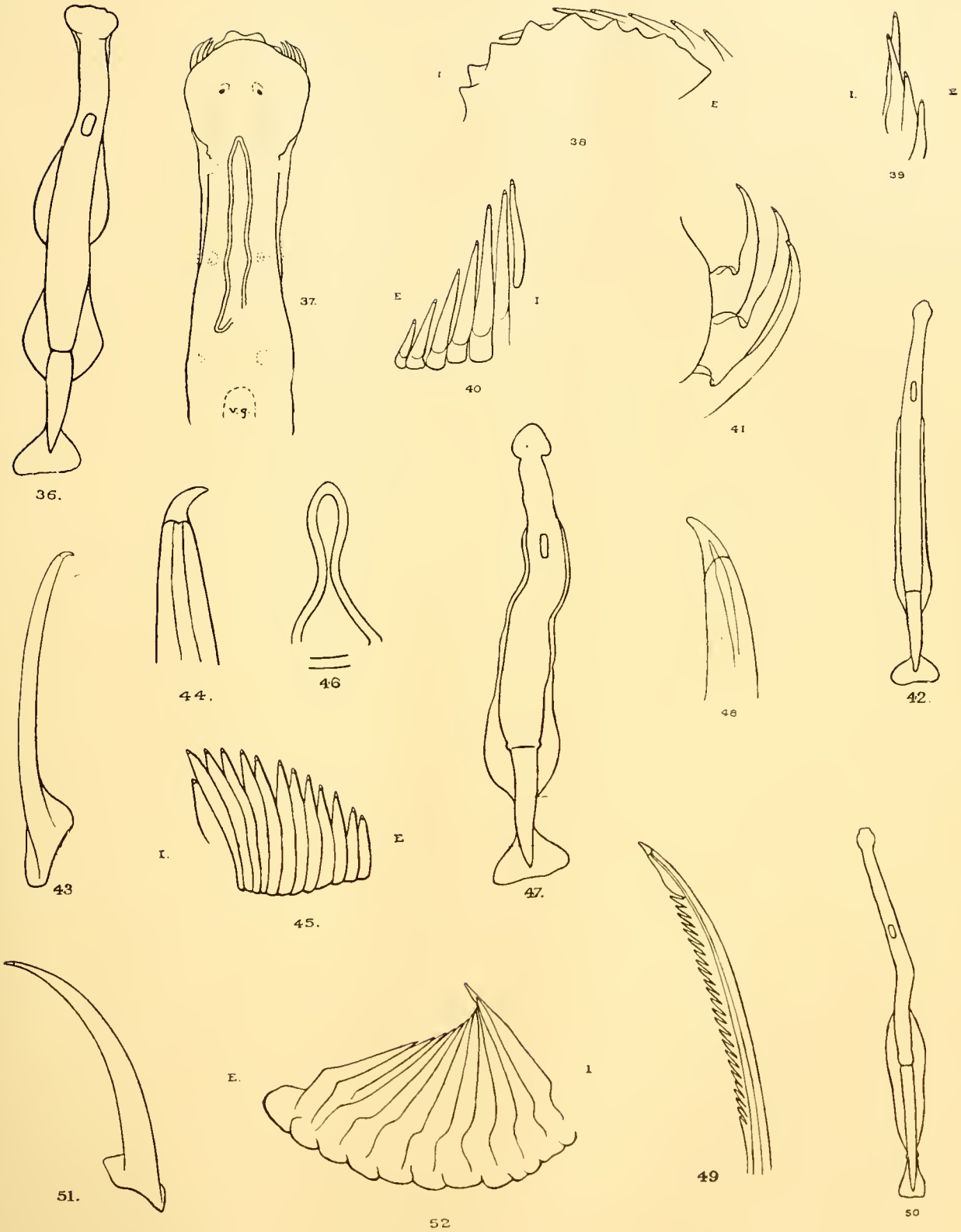
BISCAYAN CHÆTOGNATHA.

Figs. 16–21. *Sagitta macrocephala*; 22–27. *Sagitta zetesios*; 28–31. *Sagitta bipunctata*; 32–35. *Sagitta decipiens*.



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BISCAYAN CHÆTOGNATHA.

Figs. 36–40. *Sagitta ? planctonis*; 41. *Sagitta* sp. indet.; 42–46. *Krohnia hamata*; 47–49. *Krohnia hamata*, var.; 50–52. *Krohnia subtilis*.

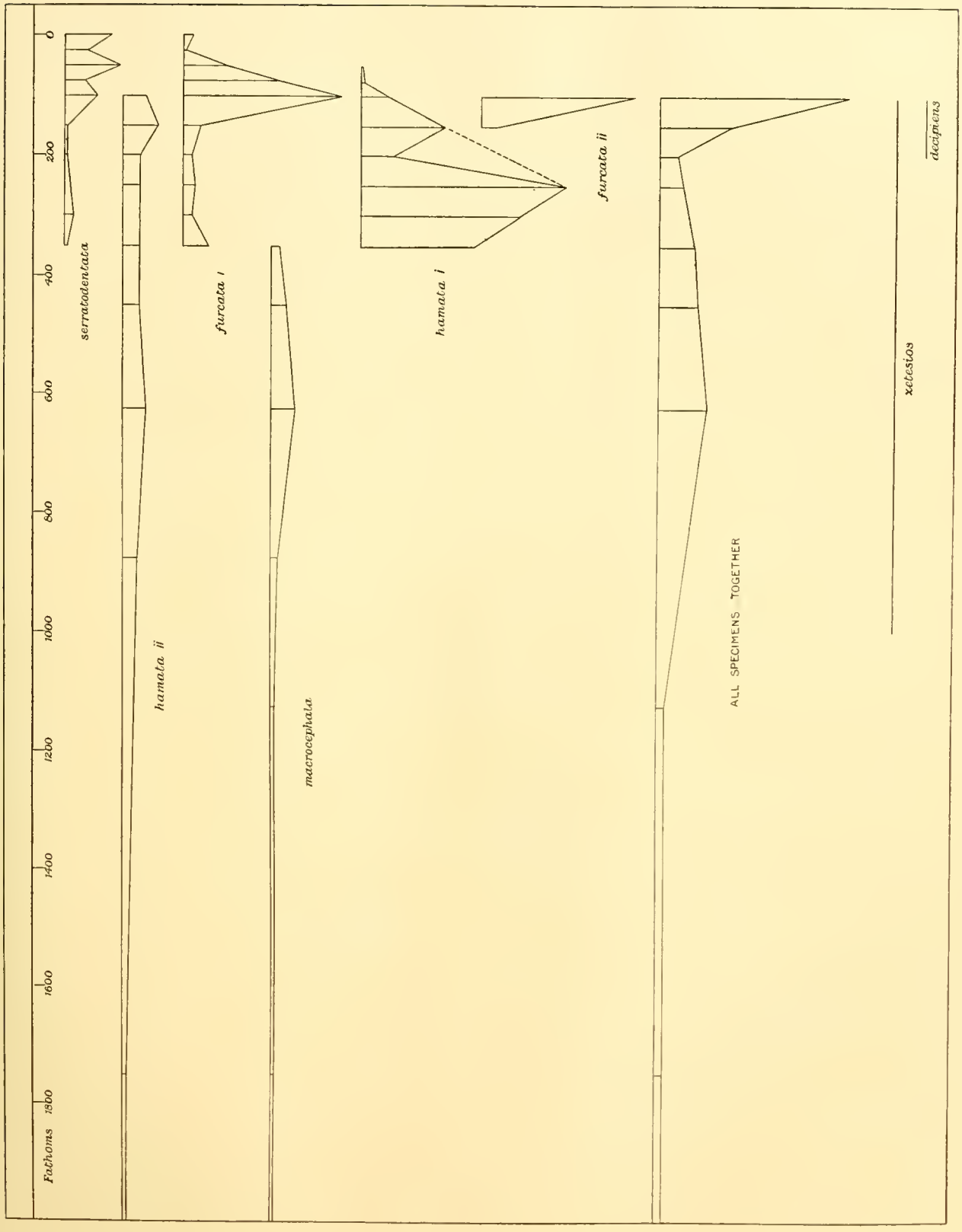

TABLE OF FREQUENCY.

BISCAYAN PLANKTON.

Part IV.—THE THALIACEA.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S., F.Z.S.*

(Plates 8 & 9.)

Read 2nd March, 1905.

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i. THE CYCLOMYARIA.

This suborder was represented only by known species of *Doliolum*, but the collection contained four apparently undescribed phases, two of which I believe to be the blastozooid and trophozooid * of *Doliolum Tritonis*. Of the four polymorphic life-phases of *Doliolum*, the gonozooids alone have been adequately described for most species; in a recent account of the genus, Dr. Borgert † gave a synoptic table which covered the gonozooids of all admitted species, but he did not attempt it for any other of the three forms presented by this remarkable organism. It will be most reasonable, therefore, to begin with the gonozooids; to pass to the phorozooids (since they are stated to be structurally identical with the former, except internally for the absence of the generative organs, and externally for the presence of the ventral outgrowth on which the gonozooid-buds are borne and for the absence of the dorsal outgrowth); and to conclude with the blastozooids and trophozooids.

a. *Gonozooids.*

Doliolum Tritonis, Herdman.

This occurred at all depths down to 100 fathoms, but never below that horizon; it is, therefore, epiplanktonic. But it did not occur in sufficient numbers (111), nor on

* Blastozooid = Amme. Phorozooid = Pflegethier. Trophozooid = Nährthier. Gonozooid = Geschlechtsthier.

† A. Borgert: 'Plankton-Expedition. Thaliacea.—C. Vertheilung der Doliolen.' I follow his synonymy.

sufficient occasions (12), for inferences to be drawn as to its habits. Only small specimens were captured; the largest was about 5 mm. long, and many were less than 2 mm.

Doliolum Krohni, Herdman.

Two gonozooids only of this species were taken, one in 21 *b*, one in 30 *h*, both in 100-fathom hauls.

Doliolum Nationalis, Borgert.

One specimen in 30 *l* (50 fathoms) was apparently referable to this species.

Doliolum sp., Borgert.

Dr. Borgert (*op. cit.*) records specimens from the hauls of the 'National' (coming, with a single exception, "aus etwas grösseren Tiefen," many of them from the closing-net), which showed a marked resemblance to *Krohni*, Herdman, as regarded the formation of the gills and alimentary canal, but recalled *rarum*, Grobben, in the form of the generative organs. To this unnamed species may be referred two specimens from 36 *l* (350 to 0 fathoms). On comparison with *Krohni*, the main differences recognizable were of the character noted by Dr. Borgert:—

	Doliolum sp., Borgert.	*Doliolum Krohni.*
Endostyle	1st intermuscular space to 5th muscle.	2nd intermuscular space to 4th intermuscular space.
Gill-plate	4th to about 6th muscle.	5th muscle to 6th intermuscular space.

But he did not record, what was very noticeable in my specimens, the extreme thinness of the muscle-bands, for they were as thin comparatively as in *Nationalis*, far thinner than in *Krohni*. The gill-slits were not exactly countable, owing to poor preservation, but appeared to be about 16 to 20 in number.

Being unable, in a single case, to find a ripening ovum in this unnamed form, Borgert suggested as a possibility that the specimens were examples of *Krohni* which had failed to reach sexual maturity (supposing them not to constitute a separate species); or, as an alternative, that the differences between them and *Krohni* might be of a pathological nature due to the depth at which they lived. There is, of course, also a third possibility, namely, that these forms are really *Krohni* which, dying before sexual maturity or after sexual exhaustion, are sinking to the bottom, and that the differences in position of some organs are attributable to post-mortem shrinkage and to distortion due to tow-net pressure. Like Borgert, I failed to find ripening ova, the cells of the ovary seemed to be all approximately equal in size; but the whole appearance of this form is so different from *Krohni*, its muscle-bands are so thin, its test so slight, that I believe it to constitute an undescribed mesoplanktonic species. My specimens are hardly good enough to allow of a diagnostic description and figures. I suggest that it is a mesoplanktonic species, not only from the 'National' captures, but also from the distribution of the phorozooid in the closing-net (p. 91).

b. *Phorozooids.*

Doliolum Tritonis, Herdman.

This was taken in 13 hauls, all between 100 fathoms and the surface. Of the 119 specimens which I have assigned to it, a few may have been young gonozooids; but the greater number (31) of minute specimens, which did not clearly show either generative organs or dorsal outgrowth, have not been reckoned as either gonozooid or phorozooid. No specimen exceeded 4 mm. in length. As we do not know at what length the phorozooids become freed, and as so many minute but recognizable gonozooids were captured, it must be left uncertain whether the larger phorozooids had been knocked off the dorsal outgrowth of a blastozooid, or were leading an independent existence; the former was probably the case. Blastozooids which I refer to *Tritonis* were present in all the hauls in which these phorozooids were taken.

Doliolum sp., Borgert.

To this may be referred two specimens (35 *o*, 250–150 fathoms; 35 *k*, 430–300 fathoms); and, with less certainty, on account of imperfect preservation, eleven further specimens (21 *m*, 500–400 fm., 4 specimens; 21 *c*, 300–200 fm., 1 specimen; 31 *d*, 1000–750 fm., 1 specimen; 27 *a*, 1250–0 fm., 5 specimens). No generative organs were seen, and the specimens were therefore probably phorozooids.

c. *Blastozooids.*

Very little is known of the specific characters of blastozooids. From the text and figures of the more recent authorities I have compiled the following table, omitting, however, two characters which are found in some definitions—the thickness of the muscle-bands, because this seems to depend upon age and size; and the shape of the true stolon, which appears (from my specimens, at any rate) to alter in successive phases of maturation and germination.

In the table, to save space, the muscle-bands are represented by i, ii, iii, &c., the intermuscular spaces by i–ii, ii–iii, &c. The authorities, indicated by square brackets in the table, are:—

A. Borgert: 'Plankton-Expedition. Thaliacea.—C. Vertheilung der Doliolen' (*Krohni*, pl. vi. fig. 13).

C. Grobben: Arb. Zool. Instit. Wien, iv. 201 (*Mülleri*, pl. iii. figs. 16–18; *denticulatum*, pl. i. figs. 3–5, pl. ii. fig. 7).

B. Uljanin: Fauna u. Flora d. Golfes v. Neapel, Monographie *Doliolum* (*Mülleri*, pl. vii. fig. 11, pl. ix. fig. 6; *Ehrenbergi*, pl. xii. fig. 8). On p. 128 the anus of *Mülleri* is described as opening in v–vi, but is drawn as lying in vii–viii on pl. vii. fig. 11: this figure seems to be wrong in some other respects—for example, the eighth muscle-band curves into the dorsal stolon and not the seventh.

	Intestine.	*Endostyle.*	*Œsophagus and Stomach.*	*Anus.*	*Gill-slits.*	*Otocyst.*
Mülleri, Krohn [Ulj., Gr.].	with U flexure.	ii–iii to iv–v.	under vi [Ulj.], in v–vi [Gr.].	in v–vi.	v–vi to vi–vii, small.	touching iv [Ulj.], on iv [Gr.].
Krohni, Herdman [Borg.].	with U flexure.	ii–iii to iv–v.	œs. under vi, stom. in v–vi.	under vi.	v–vi to vi–vii, small.	touching iv.
denticulatum, Q. & G. [Gr.].	nearly straight.	ii–iii to iv–v.	in v–vi.	under viii.	v to vi–vii, large.	in iii–iv.
Ehrenbergi, Ulj., not Krohn [Ulj.].	nearly straight.	ii to iv–v.	in v–vi.	under viii.	v to vi–vii, large.	in iii–iv.
Blastozooid A (? = *Tritonis*, Herdman) [G. H. F.].	nearly straight.	ii–iii to v.	in v–vi or under vi.	from under viii to ix.	v–vi to vi–vii, large.	in iii–iv.

Between the first two there is practically no difference, and but little distinction can be drawn between the last three. Although the separating characters are not the same in the two generations, the gonozooids of the first two species similarly belong to one group of gonozooids, those of the last three to another.

Out of the numerous well-preserved blastozooids in the collection, not one had retained on its dorsal outgrowth phorozooids of sufficient size to be identified specifically. The experience of the 'National' was similar; the older buds become very easily detached. It is only, therefore, through indirect evidence that the blastozooids and trophozooids can be linked with their proper species. Such evidence I propose now to attempt.

In 14 out of the 50 hauls at 100 fathoms or less which contained *Doliolum* of any kind, occurred either gonozooids or phorozooids, or both, referable to *Tritonis*, amounting in all to 111 * gonozooids and 119 * phorozooids. In 2 out of these 50 hauls were found gonozooids referable to *Krohni*; in 1 only a gonozooid belonging to *Nationalis*. Expressed in a comparative table, of the total gonozooids captured:

97·3 per cent. were referable to *Tritonis*,
1·7 „ „ „ *Krohni*,
·8 „ „ „ *Nationalis*;

and there occurred gonozooids of:

Tritonis in 28 p.c. of hauls containing *Doliolum*,
Krohni in 4 „ „ „
Nationalis in 2 „ „ „

In every one of the 50 hauls at 100 fathoms or less which contained *Doliolum* of any kind occurred blastozooids, amounting to 922 specimens. In about sixteen of these

* Actual numbers, not multiplied by time-factor; all nets at 100 fm. or less.

cases occurred small specimens, some 400 in number, which had not begun or had not completed their degeneration, and therefore showed their characteristic structure: they were demonstrably of a type hitherto undescribed. The remaining blastozooids (excepting four, possibly five, specimens to be dealt with later) appeared to pass by easy gradation into this type, though altered by the usual metamorphosis and degeneration. In every case in which phorozooids of *Tritonis* were captured this blastozooid occurred.

The presumption is that this undescribed blastozooid belongs to one of the species already captured in the North-eastern Atlantic, namely, to *denticulatum*, *Nationalis*, *Krohni*, *Tritonis*, or *sp.*, Borgert *. Of these, *denticulatum* is known only as a warm-water form, and has not been taken north of 42° N.; *D. sp.*, Borgert, is apparently a deep-water form, and I did not take it above 250–150 fathoms; the blastozooid of *Krohni* has been well figured and described, and does not agree with the one before us; there remain *Nationalis* and *Tritonis*. As between these two, the presumption is enormously in favour of the one to which belong 97 per cent. of the gonozooids and all the phorozooids. In default, therefore, of characters which enable older blastozooids to be specifically differentiated, I refer all blastozooids from the epiplankton (except the five already referred to) to

Blastozooid A (? = Doliolum Tritonis, Herdman).

The table (p. 92) and the drawing (Pl. 8. fig. 1) sufficiently show the diagnostic characters.

In the case of the Thaliacea, as in that of the Chætognatha, I have endeavoured to sort out every specimen in the collection. That this is practically impossible, especially when dealing with minute specimens, I know well; even if every particle of the catch were sorted out into its respective Order (which has not in every case been done), there would remain, in rich hauls from 100 fathoms particularly, specimens tangled together in clots from which they can only be freed by tearing them. In such hauls the error in minute specimens may perhaps be as much as 10 per cent.†; in the poorer hauls it drops proportionately, till it becomes zero. But I believe the approximation to accuracy to be close enough to allow one to handle the resulting statistics of population (compare Methods and Data, p. 7, *supra*), and in any case the conclusions based on counted specimens can only be put forward provisionally for confirmation or refutation by future observers.

The hauls used for statistics may be regarded as fairly comparable, except for the varying rate of the ship's drift: for this factor no proper correction can be made. Hauls made with a small-mouthed net of 180 meshes per linear inch have been neglected, as in the case of Chætognatha, because the catching-power was obviously so slight (simultaneously, 180 meshes caught none, 60 meshes caught 68 specimens; 180 meshes caught none, 60 meshes caught 10 specimens). Hauls with a net of about 18 meshes per linear inch, and a diagonal of the mesh-aperture about 1·5 mm., have also been omitted (but not in the case of the larger Chætognatha), as allowing small specimens to slip through.

In the course of the second day's work (July 8) we struck a "swarm" of *Doliolum*, a remarkable feature of which was that, unlike the swarms of gonozooids hitherto described,

* *Vide* Chart, Pl. 9.

† Mr. J. J. Lister, testing this in *Hastigerina*, found in rich hauls an error in my sorting of 5 to 6 per cent.

it consisted almost entirely of blastozooids. For example, haul 21 *h* at 100 fathoms yielded the following determinable and measurable specimens * in half an hour :—

Blastozooids :	2 mm. and less in length	. . . . .	369
	3 „ „	. . . . .	43
	4 „ „	. . . . .	16
	5 „ „	. . . . .	10
	6 „ „	. . . . .	10
	7 „ „	. . . . .	4
	9 „ „	. . . . .	1
Gonozooids :	2 „ „	. . . . .	2
	3 „ „	. . . . .	1

This puzzling appearance of numerous specimens of the same generation termed a "swarm" has been discussed at some length by Dr. Borgert. He refers the swarming to the more or less seasonal occurrence of optimal conditions, such as food and temperature (*op. cit.* pp. 61–63); but he rejects (*op. cit.* pp. 49, 50) the idea that species of *Doliolum* have regularly recurrent periods of reproduction, on the following grounds :—(1) that all the eggs of the gonozooid do not ripen simultaneously, and therefore the resulting blastozooids will be of different ages and sizes; (2) that the blastozooids and phorozooids are productive for a considerable time, and their successive "progeny" therefore will be even more markedly of different sizes and ages: thus the effect of a swarm produced under optimal conditions will be dissipated and untraceable in the course of a complete cycle of reproduction.

On the other hand, the presence of such large numbers of minute blastozooids as were taken on July 8 certainly seems to me to demand the pre-existence of a "swarm" of gonozooids, since the ovary of the specimens examined contained generally only one large ovum, although plenty of smaller ova.

The swarm was apparently confined to a small space; on the next day, July 9, at a distance varying from 8 to 20 miles away in a N.W. direction, it was not certainly recognizable. On July 11 we were again 8 miles from the original position, this time a little N. of E.; the average catch per haul that day was 2·6 instead of 314. On July 12, 9 miles S.E. of the original position, the average catch † per haul was 4·5. Yet the whole area covered by our stations was so small that the conditions of food and temperature were presumably uniform throughout, and, if optimal at one point, ought, on Dr. Borgert's theory, to have affected the whole area, and to have produced a uniform swarming: this was obviously not the case.

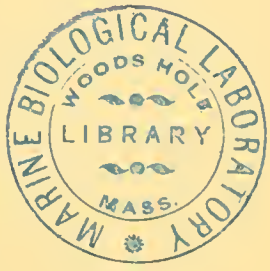
But though the "swarm" was apparently local, yet sporadic sexual reproduction appeared to have taken place simultaneously over, at any rate, a large part of the area under observation. This would appear from the following table ‡ :—

* Actual numbers, not multiplied by a time-factor.

† The daily average catches per haul have been plotted on the chart of positions, but yielded no obvious result.

‡ Days of 24 hours, midnight to midnight. The specimens were roughly measured as 2 mm. or less; 3 mm. or less, but more than 2; 4 mm. or less, but more than 3, &c.; and the average length struck on these measurements. They seem to show the comparative daily lengths, but would not be accurate enough to determine (say) rate of growth.

Day.	Average length of specimens. (mm.)	Length of smallest specimens. (mm.)	Length of largest number of specimens. (mm.)
July 8	2·3	2·0	2·0
9	2·8	2·0	2·0
10	4·8	2·0	2·0
11	5·5	3·0	5·0
12	5·6	4·0	5·0
13	6·2	4·0	7·0



After this there was a break of five days in the observations, due to deep-water work and to our running into Brest for coal; except on the 19th and 20th we caught few specimens, and the figures, both of average specimens per haul per day and of average and actual lengths per day, are orderless. That sporadic sexual reproduction had occurred subsequently to the first "swarm" is, however, seen from the fact that specimens of 2 mm. and less were caught (for the last time) on the 19th.

We may conclude from the above: that a swarm of blastozooids may be formed, as well as a swarm of gonozooids; that it seems to demand the previous occurrence of a swarm of gonozooids; that some further explanation of the production of the swarm is required than mere optimal conditions of food and temperature, because the swarm is so local, even when sporadic reproduction is going on in the surrounding area.

I had hoped that these blastozooids were present in sufficient numbers and occurred on sufficient occasions to enable a test to be made of their reaction to light by the method used for *Sagitta serratodentata* (Part III. pp. 60–61, above). But the attempts at this were invalidated by the presence of the "swarm," which sent up the values of the depths (50 and 100 fathoms) at which it occurred in a manner quite disproportionate to those obtained for the remainder of the cruise. For example, the average specimens * per hour haul at 100 fathoms between 3.0 A.M. and 7.0 P.M. were 93·5 if the swarm-haul 21 *h* was included, but 3·2 if it was omitted! I therefore separated the swarm-hauls 21 *e* to 21 *i*, and although they by themselves seemed to indicate a movement of the swarm to the surface at night, yet the placing of the remaining hauls on day-and-night tables gave no satisfactory result: it neither confirmed nor denied any vertical oscillation, either because both specimens and observations were too few, or, more probably, because no such vertical oscillation exists in this species. But the contrasting of hauls in dry weather, irrespective of time of day, with those made during or after rain

* In this section the actual numbers caught have been treated with the time-factor; nets 18 and 180 omitted; and averages struck over all hauls, not merely those in which the blastozooid occurred.

markedly showed much the same avoidance of the surface as was noticeable with *Sagitta serratodentata* (p. 61, *supra*). Both sets of figures include day and night hauls; the swarm-hauls 21 *e* to *h* (21 *i* was with net 18) are also included:—

At fathoms	hauls in dry weather the average catch per hour was	specimens, but in	hauls during or after rain the average catch per hour was	specimens.
0	10	9·4	3	0
25	9	0·6	3	7·3
50	10	10·4	3	22·0
75	10	2·8	1	3·0
100	19	49·8	2	7·0

Were the swarm-hauls omitted, the dry-weather values for 0, 50, and 100 fathoms would be 10·4, 6·8, and 2·1; and the contrast would be even more marked.

In the following table the swarm-hauls have been omitted, in order to get an idea of the vertical distribution of these blastozooids irrespective of swarms:—

At fathoms	fathoms they occurred in	per cent. of	hauls, yielding	average specimens per hour haul.
0	41	12	7·8	
25	58	12	2·3	
50	83	12	10·3	
75	72	11	2·8	
100	55	20	2·6	

Both percentages of hauls and average specimens per hour indicated that 50 fathoms was the optimal horizon *.

Average lengths per depth, when tabled, did not show that older specimens sought a different level from the younger specimens.

We may summarize the foregoing paragraphs as follows:—The captures, as a whole, yielded no evidence for or against a day and night oscillation; but they markedly indicated an avoidance of the surface during or after rain, the species becoming most plentiful at 25 and 50 fathoms; the average expectation of specimens is highest at 50 fathoms, which may be taken to have been the optimal horizon for the date and area studied.

In epiplankton hauls at or above 100 fathoms these blastozooids occurred in 65 per cent. of the total hauls; below 100 fathoms they vanished; on three occasions only (*cf.* Table, pp. 100–101) there were taken in the mesoplankton net from considerable depths fragments of very large specimens of a blastozooid, mostly larger than any of the epiplankton specimens. These may have been dead specimens of Blastozooid A, or may even possibly belong to a deep-water species. But there can be no doubt that Blastozooid A is epiplanktonic.

* It is curious that, on whatever principles such statistics are arranged, the average specimens at 50 fathoms always have much higher values than at 75 and 25 fathoms. The same was observed in *Sagitta serratodentata*.

Blastozooid B.

A single specimen, which had completely degenerated and was in very bad condition, exhibited muscle-bands thinner than in those attributed to *Tritonis* at a corresponding length. It would not have been recorded here, but for the fact that it occurred in the same haul as some trophozooids to be described (p. 98).

Doliolum Krohni, Herdman.

Specimens which seemed to agree with Borgert's figures and description occurred in 32 *h* (50 fm., 1 specimen) and 34 *c* (75 fm., 3 specimens).

As all blastozooids are so much alike after degeneration (which in Blastozooid A sets in generally at about 2·50 or 2·75 mm. of total length), it is a little difficult to see what criterion can ever be applied to their specific determination, the organs ordinarily used in diagnosis having disappeared. As an experiment in this direction, which I hope may be repeated by someone else in another species, I have measured the width of the fourth muscle-band in fifty specimens of various lengths, and give in the following table the means (not averaged) at those lengths :—

Total length.	Mean width of muscle-band iv in μ.
3 or more, less than 4 mm.	270
4 „ „ 5 „	502
5 „ „ 6 „	575
6 „ „ 7 „	810
7 „ „ 8 „	880
8 and more	1012

d. *Trophozooids.*

Trophozooid A (? = Doliolum Tritonis, Herdman). (Pl. 8. figs. 2, 3.)

In 8 out of the 50 hauls between 100 fathoms and the surface, which contained *Doliolum* of any kind, occurred an undescribed but characteristic trophozooid, amounting to 106 specimens. It is stated that trophozooids are unable to lead an independent existence ; we may therefore expect to find the corresponding blastozooid in the collection. The mere numbers captured indicate a very great probability that this form belongs to the Blastozooid A, which I have provisionally assigned to *Tritonis*.

The only trophozooids hitherto figured and described with any approach to specific certainty are those of *Mülleri*, Krohn, *Ehrenbergi*, Uljanin non Krohn, and *denticulatum*, Quoy and Gaimard. At the outset we are met by the difficulty that the figures of the trophozooid of *Mülleri* given by Grobben (pl. ii. fig. 9) and Uljanin (pl. xi. fig. 9) do not

agree together; and I incline to doubt that they are really of the same species: in the synoptic table below * I have kept them separate from one another:—

	Intestine.	*Anus.*	*Endostyle.*
denticulatum [Grobben].	widely apart from stomach.	anterior to œsophagus.	short, posterior, on level with stomach.
Müllerí [Grobben].	fairly close to stomach.	posterior to œsophagus.	short, far posterior, behind stomach.
Müllerí [Uljanin].	fairly close to stomach.	on level with œsophagus.	fairly long, from level of œsophagus to that of stomach.
Ehrenbergi [Uljanin].	widely apart from stomach.	posterior to œsophagus.	long, from well in frout of œsophagus to behind stomach.
Trophozooid A (? = *Tritonis*) [G. H. F.].	tightly coiled with stom. and œsoph.	anterior to œsophagus.	short, posterior, on level with stomach.
Trophozooid B [G. H. F.].	fairly close to stomach.	posterior to œsophagus.	long, from far in front of œsophagus to well behind stomach.

These Trophozooids A, which I refer provisionally to *Tritonis*, differ in one point or another from all those yet described, notably and from all in the fact that the whole alimentary canal is tightly compressed together, almost like a *Salpa* "nucleus." Many of the specimens were in very good condition, and the points of difference are therefore not likely to be due to preservation.

As regards the scale-like projections figured by both Grobben and Uljanin, some of my specimens had two, some one, some none. It is probable that they belong rather to the dorsal outgrowth of the blastozooid than to the trophozooid, and that their presence, like the length of the stalk, depends on how and where the trophozooid is broken off. The specimen in Pl. 8. fig. 2 had no scale, that in fig. 3 showed two, folded over: they react to hæmatoxylin like the test. The long sense-processes figured by Grobben had generally been knocked off, but were observed in some specimens.

Trophozooid B. (Pl. 8. figs. 4, 5.)

In 3 out of the 50 hauls between 100 fathoms and the surface occurred trophozooids of another character—in all four specimens. In only one of these hauls was there caught a blastozooid † not obviously like Blastozooid A; this has already been mentioned in Blastozooid B (p. 97).

* As with the blastozooid, the authority for the description and figure has been enclosed in square brackets.

† Of course, the presence of these trophozooids, although only 3·6 p.c. of the total number, renders less assured my reference to *Tritonis* of all the 917 blastozooids quoted as A. But if this reference be not accepted, the non-degenerate specimens can be quoted simply as Blastozooid A, the rest over 3 mm. left doubtful; and the remarks about swarming, reaction to rain, optimal horizon, &c., can be taken to refer to blastozooids as a whole irrespective of species, since they omit only 5 specimens.

ii. THE HEMIMYARIA.

This group presented no features of great interest, unless the scarcity of its representatives be reekoned as sueh. So far as the captures go, they confirm the conclusion of Apstein * that *Salpæ* do not extend deeper than about 218 fathoms (400 metres), as the lowest haul with the closing-net which contained *Salpæ* was 35 *o*, 250–150 fathoms. At no horizon were they plentiful; only 29 specimens were distributed over 15 hauls.

The occurrences are noted in the General Table (pp. 100–101).

The speeies eaptured were:—

Salpa runcinata-fusiformis, Cham. Cuv.

Of these there were eight *gregatæ*, one *solitaria*.

Salpa echinata, Herdman (?*fusiformis*, var. *echinata*, Apstein).

Two specimens were taken, by which the distribution of the speeies is considerably extended northward.

Salpa democratica-mucronata ?, Forskål.

Eighteen badly damaged speeimens were perhaps referable to the *gregata* form of this speeies.

In the following General Table of Distribution the first three hauls are those made with the closing-trawl.

The letters have the following significanee:—

B = Blastozooid.	P = Phorozooid.
G = Gonozooid.	So = Solitaria.
Gr = Gregata.	T = Trophozooid.

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* C. Apstein: 'Die Thaliacea der Plankton-Expedition.—B. Vertheilung der Salpen,' p. 49.

Depth in fathoms.	Haul.	*Doliolum Tritonis.*	*Doliolum* B.	*Doliolum Nationalis.*	*Doliolum Krohnii.*	*Doliolum* sp., Borgert.	*Salpa maxima-fusiformis.*	*S. echinata.*	*S. democratica-mucronata?*
500—250	29 *a*								
1500—750	30 *a*								
2000—1000	30 *e*								
0	21 *e*								
	21 *f*								
	21 *i*	B G P							
	22 *d*	B P T	T						
	22 *e*	B P T							
	22 *g*	B							
	23 *b*	B G P T							
	23 *c*								
	23 *d*	B G P T	T						
	23 *e*	B G P T							
	24 *c*								
	24 *f*								
	24 *g*								
	24 *h*								
	24 *i*	B							
	24 *k*								
	25 *a*								
	25 *b*								
	25 *h*								
	25 *i*								
	25 *l*								
	30 *c*								
	32 *c*								
	33 *a*								
	33 *b*								
25—0	26 *a*	B							
	30 *b*	B							
	30 *m*	B G P							
	31 *a*	B G P							
	32 *b*								
	32 *e*	B							
	33 *e*	B	....	....	....	....	Gr		
	33 *g*								
	34 *a*								
	34 *g*	B							
	35 *w*								
	36 *c*								
50—0	21 *g*	B G P T							
	25 *e*								
	25 *g*	B							
	25 *k*	B	....	....	....	....	Gr		
	26 *c*	B							
	30 *d*	B G	B T						
	30 *l*	B G P	....	G					
	31 *b*	B G P	....	....	....	....	Gr		
	32 *a*	B							
	32 *h*	B	....	....	B				
	33 *c*	B							
	33 *f*	....	....	....	....	....	So		
	36 *d*	B							
75—0	30 *f*	B							
	32 *g*	B							
	32 *m*	B							
	32 *o*	B							
	33 *h*	B							
	34 *c*	B	....	....	? B				
	35 *a*	B							
	35 *c*								
	35 *e*								
	35 *y*	....	....	....	....	....	....	So	
	36 *a*	B							

Depth in fathoms.	Haul.	*Doliolum Tritonis.*	*Doliolum* B.	*Doliolum Nationalis.*	*Doliolum Krohni.*	*Doliolum* sp., Borgert.	*Salpa runcinata-fusiformis.*	*S. echinata.*	*S. democratica-mucronata?*
100—0	21 *h*	B G P T	....	....	G				
	21 *l*	B							
	22 *a*	B							
	24 *b*	B							
	24 *d*	B							
	24 *e*	B							
	25 *d*	B							
	30 *g*	B G P T							
	30 *h*	B	....	....	G				
	32 *d*	B							
	32 *i*	B							
	32 *n*	B	....	....	....	....	....	....	Gr
	32 *p*	B							
	33 *d*	....	....	....	....	....	Gr		
	34 *b*	....	....	....	....	....	....	So	
	34 *d*								
	35 *b*	....	....	....	....	....	....	....	Gr
	35 *d*	....	....	....	....	....	....	....	Gr
	35 *f*	B							
	35 *x*	B	....	....	....	....	....	....	Gr
	36 *b*	B							
	36 *e*								
150—0	36 *f*	....	....	....	....	....	....	....	Gr
150—50	21 *p*								
150—100	21 *n*								
200—0	21 *a*								
	36 *g*								
200—100	21 *b*								
	21 *o*								
	26 *e*								
	34 *h*	.. .	....	....	....	....	....	....	Gr
	35 *m*								
	35 *n*								
	35 *t*								
250—0	36 *h*	....	....	....	....	....	....	....	Gr
	36 *i*								
250—150	35 *o*	....	....	....	....	P	....	....	Gr
	35 *p*								
	35 *s*								
300—0	36 *k*								
300—200	21 *c*	....	....	....	....	P			
	26 *f*								
	35 *l*								
350—0	36 *l*	....	....	....	....	G			
400—300	21 *k*								
	32 *l*								
	35 *k*	....	....	....	....	P			
500—400	21 *m*	....	....	....	....	P			
	35 *h*								
	35 *i*								
750—500	22 *b*								
	30 *k*								
	34 *e*	? B							
	34 *f*								
1000—750	23 *a*								
	27 *c*								
	31 *d*	? B	....	....	....	P			
	32 *f*								
	32 *k*	? B							
1250—1000	24 *a*								
	27 *b*								
	31 *c*								
1500—1250	25 *f*								
	30 *i*								
2000—1500	25 *e*								
	26 *b*								

BISCAYAN PLANKTON.

Part V.—THE SCHIZOPODA.

By E. W. L. Holt *and* W. M. Tattersall, *B.Sc.*

(With Text-figure.)

With an APPENDIX.

By G. Herbert Fowler, *B.A.*, *Ph.D.*, *F.L.S.*, *F.Z.S.*

Read 4th May, 1905.

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* See Calman, Ann. & Mag. Nat. Hist. ser. 7, vol. xiii. Feb. 1904, on "Classification of Malacostraca," where it is proposed to divide the Malacostraca into three divisions: *Eucarida*, *Peracarida*, and *Hoplocarida*.

We have examined the whole of the Schizopods collected by Dr. Fowler, who has attempted to sort out every specimen from even the largest gatherings, for fear that our preliminary results, based upon samples, might not truly express the facts of vertical distribution. We found, however, that the conclusions deduced from examination of the material taken from the first half of a large gathering were not disturbed by the overhaul of the remainder, and imagine that this will probably hold good for other plankton collections, except in regard to organisms which are so small that their distribution in store-bottles is determined by considerations of gravity.

The collection naturally included a large number of ova and larvæ, the distribution of which is of undoubted importance, but in this communication we name only the larvæ of a few species which happen to be absolutely determinable. The remainder are reserved for a further note, in which, with the aid of a large collection from the West of Ireland (a region practically identical in specific Schizopod fauna with the Biscayan region), we hope to be able to add materially to the knowledge of the young stages.

Our report deals, therefore, only with specimens which have or have nearly assumed the adult form, or which, if larval, are exempt from the possibility of confusion with the larvæ of species other than those to which we have assigned them.

When the collection was placed in our hands, we were engaged in the study of similar forms taken from deep water off the West Coast of Ireland, and, with Dr. Fowler's permission, we have included in the Irish paper * such systematic notice as was required by the Biscay material, with some general remarks on the horizontal and vertical distribution of all the species determined.

Only one form, a Mysid of the genus *Euchætomera*, is new to science. We have named it in honour of its discoverer, and, as appears from the figure, it is rather closely allied to *E. tenuis*, G. O. Sars, from the S. Pacific. Its range as at present known includes Bay of Biscay ('*Research*'), W. of Ireland ('*Helga*'), Atlantic 31° 06′ N., 24° 06′ 45″ W. (*Hansen*), and Mediterranean (as *E. tenuis*, Lo Bianco).

For general convenience, we reprint here our diagnosis of the species:—

Euchætomera Fowleri, Holt & Tattersall †. (Text-figure.)

Form slender. *Integuments* thin and diaphanous. *Carapace* with the anterior margin forming a very obtuse angle in the rostral region, its apex considerably posterior to the origin of the peduncles of the eyes; its posterior margin not deeply emarginate. *Eyes* large, closely apposed, sub-rhomboidal and slightly bilobate, their functional facets confined to an anterior part with long retinal elements, and a postero-lateral part with short retinal elements; these parts deeply pigmented, the pigment dark brown after preservation, the remainder of the eye being pale brown, with facets vestigial and probably functionless. *Antennular peduncle* with the basal joint about one and a half times as long as the eye, distal joint as long as the two preceding; male appendage

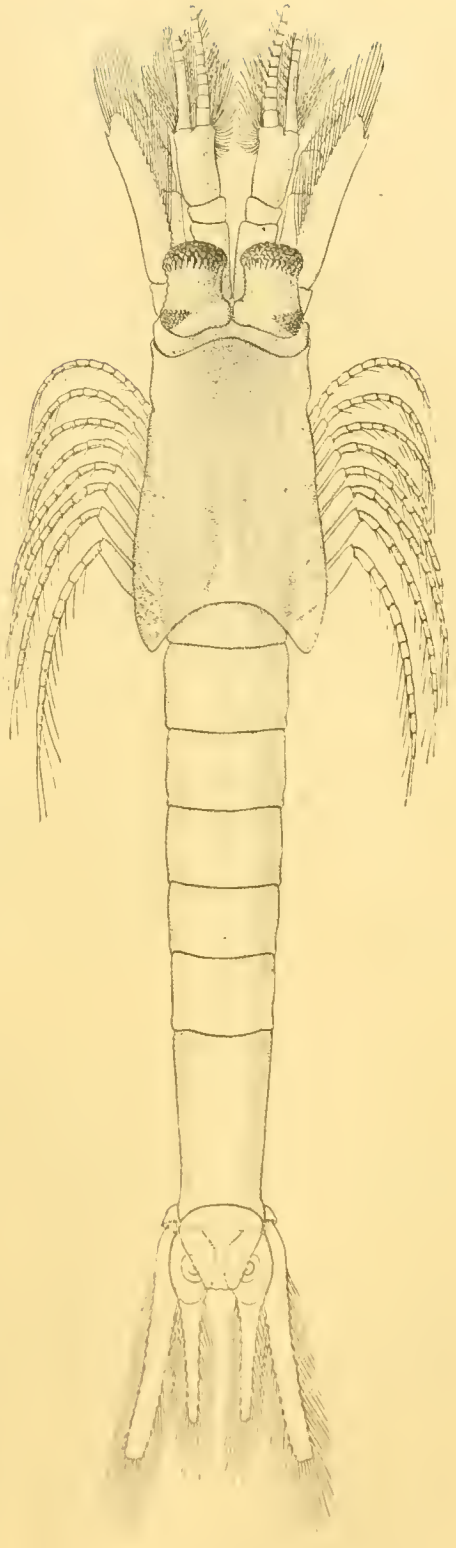
* "Schizopodous Crustacea from the North-East Atlantic Slope." Report of Sea and Inland Fisheries, Ireland, for 1902 and 1903, pt. ii. Appendix No. IV.

† *Ibid.* p. 123, pl. xxiv. figs. 1–3.

densely setose in the adult; internal flagellum very long, the proximal joints remarkably setose. *Antennal peduncle* nearly as long as antennular peduncle, its last joint shorter than the preceding. *Antennal scale* slightly curved, about five times as long as broad, extending for about one-seventh of its length beyond the antennular pedunele; external margin entire, terminating in a very feeble spine; apex obliquely truncate, extending beyond the spine. *Thoracic limbs* in the male with well-developed exopodites, the basal part terminating in a minute spine; flagelliform part with eleven joints, and, in the last three pairs of limbs, of about five-sixths of the length of the carapace. *Pleon* somewhat narrower than the carapace, with the first five segments subequal, the sixth considerably longer than the two preceding segments. *Telson* short, its lateral margins slightly arcuate and unarmed; apex slightly arcuate, its exterior angles armed with two closely-set short slender spines; median setæ not closely apposed, somewhat less distant from each other than from the angular spines. *Outer uropods*, including basal articulation, about once and a half times as long as the sixth segment of pleon; narrow, with the apices obliquely truncate and hardly at all rounded; setæ somewhat widely separate, about eleven on the outer margin. *Inner uropods* considerably shorter than outer; otocyst very large, extending to or beyond the extremity of the telson; distal part narrow, the apex rounded; no spines on the inferior surface; no denticulations on the inner edge.

Length of adult male and female 9 mm.

E. Fowleri is very closely allied to *E. tenuis*, described by Sars from the S. Pacific off Chili. It is, however, readily distinguished by three characters:—(i.) the eyes have no dark pigment except at the anterior and postero-lateral functional parts; (ii.) the rostrum, if it can so be called, is much more obtuse in *E. Fowleri*; (iii.) the telson has two distinct, if minute, spines at each angle, and the setæ arise at a considerable distance from each other.



Euchætomera Fowleri, Holt & Tatt.
(The armature of the telson is not shown.)

Euphausia Müllerı, Claus.

Hansen, in the later of his papers referred to below has shown that this species is apparently confined to the Atlantic and Mediterranean.

Thysanopoda microphthalma?, G. O. Sars.

Sargasso Sea and Tropical Atlantic (*'Challenger'*); Indian Ocean (*Wood-Mason & Alcock*); Irminger Sea, off Greenland (*Ortmann*); Färoe Channel (*Fowler*); Bay of Biscay (*H. & T.*).

The geographical range of this species is therefore considerable, but the records are isolated and many gaps exist. With regard to the records of this form by Ortmann and Fowler, it may be noted that the former points out some differences between his specimens and Sars's descriptions and figures. Fowler, whose examples from the Färoe Channel agreed with those described by Ortmann, doubts the identity of the form with Sars's species. The larvæ from the Bay of Biscay which we have referred to *T. microphthalma*, G. O. Sars, contribute nothing to the solution of this point, since they are not far enough advanced in development.

Meganyctiphanes norvegica (M. Sars).

This species is known from the temperate and Arctic waters of the Atlantic Ocean and the Mediterranean, and its distribution has been completely traced from Portugal, by way of the Atlantic coasts of Europe, across the Arctic Ocean to the Atlantic coasts of North America. From the intermediate waters between Europe and America it has not yet been recorded. This distribution is somewhat curious and tends to prove that *M. norvegica*, though often going far from land, is not a truly oceanic form. It is probably confined to the upper waters of the ocean, at least near its most seaward limits.

Thysanoëssa gregaria, G. O. Sars.

The collection includes some specimens of *Thysanoëssa gregaria*, a species to which may belong, as we suspect, some mangled Biscayan examples which Caullery ("Campagne du Caudan," Ann. Univ. Lyon, 1896) has referred to the northern and littoral (or sub-littoral) *T. neglecta*.

T. gregaria seems to have an exceeding wide geographical range. It has been recorded from the North, Equatorial, and South Atlantic, Mediterranean, Pacific from Japan to the coasts of Australia, but some of the material, including possibly our own, may prove to be referable to *T. parva* (Hansen, *op. cit.* p. 25).

Nematoscelis megalops, G. O. Sars.

Off Nova Scotia and Buenos Ayres (*'Challenger'*); coasts of Great Britain and Ireland (*Norman*, and *H. & T.*); Bay of Biscay (*H. & T.*); seas off Greenland and Labrador (*Ortmann*).

This is a truly oceanic form confined to the tropical and temperate waters of the Atlantic and occasionally penetrating to the Arctic seas.

Nematobrachion boöpis (Calman) *.

This Euphausian, of which eight specimens were taken by the 'Research,' was previously known from a single specimen only. The record suggests that it is not a denizen of the surface.

It has as yet only been met with in the Eastern part of the North Atlantic (see Holt & Tattersall, *op. cit.* p. 140; and Hansen, Bull. Mus. Océan. Monaco, xxx. 1905, p. 29).

Stylocheiron Suhmii, G. O. Sars.

Widely distributed over the North and South Atlantic Ocean and the Mediterranean, though not extending into Arctic waters. It is an oceanic form confined to the upper strata of the oceans. We follow Hansen (*op. cit.* p. 30) in regarding *S. longicorne* and *S. mastigophorum* as synonyms.

Stylocheiron abbreviatum, G. O. Sars.

West Coast of Ireland, Bay of Biscay; Mediterranean; South Atlantic and Pacific Oceans. *S. chelifer*, Chun, is a synonym.

Bentheuphausia sp.

A specimen of *Bentheuphausia* is, unfortunately, too small and too fragmentary to allow us to positively assign it to a species, but we suppose it is referable to the only known representative of the genus, *B. amblyops*, G. O. Sars, which has been taken in the Bay of Biscay by the Prince of Monaco †.

B. amblyops has been met with in widely separated localities, namely, the Tropical and Southern Atlantic, in the seas to the south of Australia ('*Challenger*'), in the Indian Ocean (*Alcock*), and in the Bay of Biscay. The range of the species is therefore enormous, and it will doubtless be met with in the intermediate waters when these come to be explored.

Eucopia unguiculata (Will.-Suhm).

This seems to be a widely distributed Atlantic form. For its synonymy see Hansen, Bull. Mus. Océan. Monaco, xlii. 1905, p. 3.

Many of these forms do not add much to our knowledge of horizontal distribution, but the absence of *Thysanoëssa longicaudata* (Kröyer) is interesting as indicating that the southern range of this typically northern form does not generally extend beyond the latitude of the south of Ireland.

Gnathophausia zoëa, Suhm, taken by the 'Travailleur' and the 'Caudan' in the Bay of Biscay, and by the 'Helga' on the Irish coast, is not amongst Dr. Fowler's captures; but so large an animal is probably not very numerous in individuals, and may, for anything we know to the contrary, be rather benthic than planktonic in habit.

The 'Research' gatherings, which are of plankton, naturally throw no light on the southward and bathymetric extension of the benthic Mysids which we have listed from the Irish coast.

* Report of Sea and Inland Fisheries, Ireland, for 1902 and 1903, pt. ii. Appendix No. IV. p. 153, pl. xxvi.

† Bull. Mus. Océan. Monaco, xi. 1904, p. 14, and xxx. 1905, p. 24.

Changes in Vertical Distribution.

The great interest of the 'Research' collection is found in the light which is thrown upon the changes in vertical distribution during the times of light and darkness. These changes are sufficiently explained by the tables which follow.

The first table (pp. 112, 113) simply lists the species, with numbers of individuals taken at each station. The sizes of individuals are detailed in the second list (pp. 114–117), and will, we suppose, be considered as material for the ultimate perfection of knowledge of life-history and growth, and as of some importance in regard to the weight which should be attached to the capture of an individual in such and such a net at such and such a depth in daylight or darkness.

The succeeding tables * deal with a period of twenty-four hours, from midnight to midnight. The upper strata were continuously examined by open nets towed horizontally at 100, 75, 50, and 25 fathoms, *and thence to the surface*; and by similar nets worked actually at the surface. The strata from 400 to 100 fathoms were examined by nets only in hours of daylight (in July), viz. between 10 A.M. and 7 P.M. An arm-chair critic would say that the exemption of these strata from examination at night vitiates the whole observation, but our own experience at sea leads us to wonder how Dr. Fowler achieved so much in the time. Even under the White Ensign night-work must be immensely more difficult than work by daylight.

We are dealing with a single group of organisms, and until all groups have been dealt with it appears prudent to refrain from insisting too strongly on the apparent evidence of one. If among organisms too feeble to escape any net there be found definite diurnal vertical movements, the apparent results of the Schizopod gatherings will receive support. If none such be found, then the absence of night-searching of the strata below 100 fathoms will be considered as requiring serious attention.

We select as worthy of special consideration the gatherings of *Euphausia Mülleri*, *Meganyctiphanes norvegica*, and *Stylocheiron Suhmii*, because these three Euphausians were very frequently taken during the twenty-four hours.

So far as one can judge from structural characters, *Euphausia* and *Meganyctiphanes* are about equally active when of the same size, but *Meganyctiphanes* is much the larger (maximum size 40 mm. to 26 mm.) and therefore the more powerful. Apart from its smaller size *Stylocheiron* is obviously hampered by the excessive development of some of its appendages.

Taking the feeblest form, *S. Suhmii* †, first, and neglecting gatherings below 100 fathoms, we find that it was taken at the surface thrice during the hours of darkness—10 P.M., 2 A.M., 3 A.M.,—and never in daylight. Between 25 fathoms and the surface it

* In these tables the hauls in which the species occurred are indicated by heavy type.

† It must be noted that our record of *S. Suhmii* includes all the larvæ as well as the adults, which is not the case with any other species (except *S. abbreviatum*). The list of sizes shows that larvæ greatly preponderated in the upper hauls, though not to the entire exclusion of adults. *S. abbreviatum*, G. O. Sars, occurred only in thirteen hauls, of which eleven were made by night. The captures are not sufficiently frequent for safe deduction, but if, like *S. Suhmii*, *S. abbreviatum* is a creature of the upper strata, the much greater size and consequent greater activity of the latter may explain its immunity from daylight nets.

was taken five times at night—8 P.M., 9 P.M., 12 midnight, 1 A.M., 2 A.M.,—and three times in daylight—6 A.M., 1 P.M., and 6 P.M. Between 50 fathoms and the surface it occurred in every haul throughout the twenty-four hours, and so also in the 75 and 100 fathoms hauls.

S. Suhmii is known as a creature of the upper strata of the ocean. Apparently its vertical movements in July were inconsiderable; and, indeed, if we suppose that its activity was sufficient to enable it to avoid nets visible to its remarkable optical apparatus (*cf.* Chun, Biblioth. Zool. 1888), we have no evidence of any diurnal vertical movement. However, though such a supposition might not be unreasonable in the case of adults, we cannot believe that the larvæ, which formed the bulk of the night-catches in superficial strata, could altogether avoid nets fished in daylight in the same region.

Euphausia Mülleri we take to be a much more active form, and one which in July (*e. g.* St. 23 *a*, 1000 to 750 fath.) penetrated to strata lower* than those frequented by *S. Suhmii*. During the twenty-four hours it was taken at the surface only in hours of darkness—viz. 10 P.M., 12 midnight, 2 A.M., and 3 A.M., six hauls in all. At 25 fathoms to the surface, also, it was only taken at night or at twilight—viz. at 8 P.M., 9 P.M., 11 P.M., midnight, 1 A.M., and 2 A.M. At 50 fathoms to surface it occurs in six hauls, and at 75 fathoms to surface in seven hauls, all during the hours of darkness. At 100 fathoms to surface it was taken in every haul (nine) in dark or twilight, and only in three out of thirteen hauls in daylight. There were, as the table shows, numerous hauls during daylight at the surface, and thereto from 25, 50, and 75 fathoms.

We cannot deduce from the measurement of specimens any constant difference of size in relation to vertical distribution, and since small specimens were taken at all depths it seems impossible to assume that the negative results of daylight nettings in the upper strata are unimportant. It would seem that in July there was only a remnant of full-grown *E. pellucida*, and we cannot believe that the capture of the young examples which form the bulk of the gatherings could have been seriously affected by the success of their endeavour to avoid the net, since such success must have been maintained to the not profusely illuminated depth of 100 fathoms. In our opinion *E. pellucida* in July, in the Bay of Biscay, rises at night and sinks at daylight, but far be it from us to attempt to state the vertical movements of an individual.

Meganyctiphanes norvegica, of which the individuals, though not full-grown, were all large in comparison to *E. Mülleri*, was never taken in the hours of daylight, and never even at night, in surface-nets. It occurs three times in nets towed at 25 fathoms and thence to the surface, four times in nets towed at 50 fathoms, four times in nets towed at 75 fathoms, and only becomes general in nets towed at 100 fathoms. The horizontal *locus* is, as we believe, rather far seaward from its general haunt, but we are here concerned only with its vertical movements.

Where was *Meganyctiphanes* during the day? An animal taken in fifteen night-hauls (as many as forty-two specimens in one haul) cannot have been absent from the

* Compare p. 122.

track of nets hauled through the same strata by day, unless it repaired to lower strata, which does not appear to have been the case, since many day-nettings between 400 and 100 fathoms give no account of it. We suppose that the table demonstrates that the species is subject to no marked diurnal vertical movement, but is, under such conditions of locality, season, and weather as obtained during the period of observation, an inhabitant of the upper hundred fathoms. It would further appear that specimens of 19 to 35 mm. are sufficiently sharp-sighted and active to avoid nets fished in the daytime, even as deep as 100 fathoms *.

Nematoscelis megalops is the only other species of which the hourly occurrence seems to be worth reproducing in tabular form. In activity, apart from considerations of size, we judge it to be intermediate between *Stylocheiron* and *Euphausia*. Its visual apparatus is practically the same as that of the former, but whether such an apparatus is, for the purpose of escape from nets, more or less effectual than the homogeneous eye of *Euphausia* and *Meganyctiphanes* is purely a matter of conjecture. To us the table suggests that *Nematoscelis* is subject to diurnal vertical movement, but we cannot deny that the comparative immunity of the species from capture at or near the surface in daylight may have been due to its perception of the approach of nets.

In this connection it may be permissible to advert to a familiar organism, the pelagic larva of the lobster (*Homarus*). Observed in an aquarium, or at the surface from the ship's side, it appears to be a feeble and helpless creature. Yet, though obviously a most abundant item in the coastal plankton, it is, as far as our observations go, rare in tow-nets, and seems to afford an illustration of the ease with which even a slowly-swimming crustacean can avoid capture.

In regard to *Eucopia unguiculata*, of which ten specimens were taken, Dr. Fowler's nets give the first indication of the vertical distribution. It was certainly taken by the 'Research' at least as deep as 750 fath., and at least as near the surface as 200 fath., and this is all that can be affirmed from any source of information.

With the specific determination of the material entrusted to us, and with the discussion of the vertical distribution of species by night and day, our task appears to be fulfilled. Considerations of temperature, &c., will no doubt be discussed by Dr. Fowler in the final summary of results, when all organisms detected can be treated together.

Taken by themselves, the Schizopod gatherings appear to give no very important results in regard to the influence of temperature on distribution. *Stylocheiron Suhmii* and *S. abbreviatum*, which are not known as Boreal forms, occur only in the strata which reach 52° F. (11° C.) or more; but *Meganyctiphanes*, which is a Boreal and Arctic form, and must endure much lower temperatures in the northward part of its range, was apparently confined to the same strata. *Nematoscelis megalops*, also a Boreal form, was

* We write only of the 'Research' results. The species certainly occurs at the surface, or quite near it, at night off the west of Ireland, and has been cast ashore in quantity on the North coast. In the Irish Sea, which is shallow, it is common at inconsiderable depths. Though it is taken far to sea in the upper strata of very deep water, we do not regard it as a truly oceanic form (*cf.* H. & T., *op. cit.*).

not taken in water colder than 46° F. (8° C. *ca.*), and occurred in water of 63° F. (17° C. *ca.*). The temperature range of *Euphausia Mülleri*, not Boreal, was about the same.

Other species were not taken in sufficient abundance or in sufficiently defined strata to afford absolute evidence.

Dr. Fowler has called our attention to the remarkable abundance of specimens in haul 31 *b*, and proposes, we understand, to advert to it in his own analysis of results (p. 122). We note it here merely as an illustration of the difficulty of assigning, in attempts to take a census of Plankton, its true value to the catch of each net. Close inshore, every collector knows that by hauling a net through a seam of tide the catch will often be infinitely greater than that of hauls made even a few yards on either side of the seam. Further to sea, but still within the littoral area, similar experiences of quantitative difference of catch within comparatively small areas not defined by any obvious physical phenomena are by no means unfamiliar. Here we have an oceanic instance, to which we would invite the serious attention of any who may be disposed to regard the solution of marine bionomical problems as capable of absolute mathematical solution.

[In the following General Table of Distribution (pp. 112–113), the first three hauls refer to the Mesoplankton Trawl, the remainder to "comparable" hauls * (*supra*, p. 5).

In the genus *Stylocheiron*, where every larva has been as far as possible identified, the numbers before a + sign indicate the adults, those after it the larvæ. In the remaining cases, the younger larvæ have not yet been completely worked out (p. 104), and only conspicuously identifiable larvæ have been recorded by an L.—G. H. F.]

* 21 *a*, made with a closing-net pulled up directly to the surface, should have been classed as "non-comparable." The following were the captures of the "non-comparable" hauls :—

21 *d*: 100–0 fathoms: 1 *Stylocheiron Suhmii*.

27 *a* and *a'*: 1250–0 fathoms: 2 *Eucopia unguiculata*, 1 *Bentheuphausia* sp., 1 *Nematobrachion boöpis*, 5 *Stylocheiron Suhmii*, 6 *Euphausia Mülleri*.

Depth in fathoms.	Haul.	*Euphausia Mülleri.*	*Thysanopoda microphthalma?*	*Meganyctiphanes norvegica.*	*Thysanoëssa gregaria.*	*Nematoscelis megalops.*	*Nematobrachion böopis.*	*Styloeheiron Suhmii.*	*Styloeheiron abbreviatum.*	*Eucopia unguiculata.*	*Euchætomera Fowleri.*
500—250	29 *a*	..	..	..	..	..	1				
1500—750	30 *a*	..	..	..	..	..	..	..	..	2	
2000—1000	30 *e*										
0	21 *e*										
	21 *f*										
	21 *i*	24									
	22 *d*	1	..	..	..	..	..	0+2			
	22 *e*	2									
	22 *g*	15	..	..	..	1					
	23 *b*										
	23 *c*										
	23 *d*										
	23 *e*										
	24 *c*										
	24 *f*										
	24 *g*										
	24 *h*										
	24 *i*										
	24 *k*										
	25 *a*										
	25 *b*										
	25 *h*										
	25 *i*										
	25 *l*										
	30 *c*										
	32 *c*										
	33 *a*	2	..	..	..	..	..	0+1			
	33 *b*	1	..	..	..	1	..	2+0			
25—0	26 *a*	..	..	..	..	1					
	30 *b*										
	30 *m*	4									
	31 *a*	9	..	..	..	1	..	0+3			
	32 *b*										
	32 *e*	..	..	..	..	..	..	0+2			
	33 *e*	3	..	..	..	..	..	0+3			
	33 *g*	5	..	42	..	12	..	0+8			
	34 *a*	16	..	7	..	5	..	0+5			
	34 *g*	..	..	..	..	..	..	2+2			
	35 *w*	..	..	..	..	..	..	0+3			
	36 *c*	11	..	12	..	4	..	0+1			
50—0	21 *g*	..	..	..	..	..	..	0+8			
	25 *e*	..	..	..	..	..	..	0+23			
	25 *g*	..	..	..	..	..	..	0+20			
	25 *k*	1	..	4	..	29+1 L	..	22+0			
	26 *c*	..	..	..	..	..	..	4+14			
	30 *d*	..	..	..	..	10	..	1+44			
	30 *l*	33	..	1	..	35	..	0+10			
	31 *b*	250	..	..	..	90	..	0+19			
	32 *a*	4	..	..	..	..	..	1+11			
	32 *h*	..	..	..	..	..	..	24+12			
	33 *c*	..	..	..	..	..	..	2+24			
	33 *f*	12	..	18	..	4	..	3+1			
	36 *d*	4	..	1	..	5	..	23+3			
75—0	30 *f*	..	..	..	..	3	..	36+39			
	32 *g*	..	..	..	..	..	..	2+8			
	32 *m*	16	..	3	..	17	..	30+0	1+8		
	32 *o*	5	1	20	..	25+1 L	..	28+2	0+5		
	33 *h*	27	..	21	..	2	..	5+0			
	34 *c*	10	..	6	..	26	..	30+24			
	35 *a*	11	..	..	..	..	..	10+0	2+0		
	35 *c*	4	..	..	..	..	..	8+1			
	35 *e*	..	..	..	..	..	..	0+3			
	35 *y*	..	..	..	..	..	..	5+2			
	36 *a*	5	..	..	..	..	..	5+6	1+0		

Depth in fathoms.	Haul.	*Euphausia Mülleri.*	*Thysanopoda microphthalma?*	*Meganyctiphanes norvegica.*	*Thysanoëssa gregaria.*	*Nematoscelis megalops.*	*Nematobrachion boöpis.*	*Stylocheiron Suhmii.*	*Stylocheiron abbreviatum.*	*Eucopia unguiculata.*	*Euchætomera Fowleri.*
100—0	21 *h*	..	..	..	..	..	..	5+2			
	21 *l*	1	..	..	..	..	..	0+1			
	22 *a*	..	..	..	..	..	..	0+2	1+0		
	24 *b*	..	..	..	..	3	..	20 in all	3+0		
	24 *d*	..	..	..	..	1	..	5+0			
	24 *e*	..	..	..	..	..	..	2+0			
	25 *d*	..	..	..	..	1+1 L	..	3+7			
	30 *g*	1 L	..	..	..	..	..	2+2			
	30 *h*	3 L	..	..	..	..	..	4+12			
	32 *d*	..	..	..	..	..	..	1+2			
	32 *i*	..	..	..	..	..	..	1+7			
	32 *n*	11	1 L	8	2 L	13	..	19+1	0+1		
	32 *p*	11	1 L	25	..	31	1	35+7	1+0		
	33 *d*	7	..	..	..	1	..	1+0	2+0		
	34 *b*	5	..	6	..	19	..	64+0	0+1		
	34 *d*	3	..	14	..	15+1 L	..	52+5			
	35 *b*	8	..	1	..	..	..	16+0	1+0		
	35 *d*	4	..	..	..	1	..	3+2	1+0		
	35 *f*	..	..	..	..	..	..	1+1			
	35 *x*	3	..	..	..	1	..	6+4			
	36 *b*	12	..	4	..	5	..	11+2			
	36 *e*	..	..	..	..	..	..	3+2			
150—0	36 *f*	2 L	..	..	..	..	..	2+5			
150—50	21 *p*	..	..	..	..	1	..	1+0			
150—100	21 *n*										
200—0	21 *a*	4									
	36 *g*	2	..	..	..	..	1	3+0	..	..	1
200—100	21 *b*										
	21 *o*	..	..	..	..	..	..	..	..	1	
	26 *e*										
	34 *h*	..	..	..	..	1					
	35 *m*	5									
	35 *n*	1									
	35 *t*										
250—0	36 *h*	1	..	..	..	..	1	3+2	..	..	1
	36 *i*	12	..	..	..	..	..	1+3			
250—150	35 *o*	1									
	35 *p*	10	..	..	..	..	1				
	35 *s*										
300—0	36 *k*	2	..	..	..	1 L	1	1+2			
300—200	21 *c*	..	..	..	..	..	..	0+3			
	26 *f*										
	35 *l*										
350—0	36 *l*	2	..	..	..	..	1	0+12	..	1	
400—300	21 *k*	..	..	..	..	5	..	..	..	2	
	32 *l*										
	35 *k*	..	..	..	..	..	..	..	..	1	
500—400	21 *m*										
	35 *h*										
	35 *i*										
750—500	22 *b*	..	..	..	..	1	..	..	..	1	
	30 *k*										
	34 *e*										
	34 *f*										
1000—750	23 *a*	1									
	27 *c*										
	31 *d*										
	32 *f*										
	32 *k*										
1250—1000	24 *a*										
	27 *b*										
	31 *c*										
1500—1250	25 *f*										
	30 *i*										
2000—1500	25 *c*										
	26 *b*										

Sizes of Individuals.

Euphausia Mülleri, Claus.

Synon.: *Thysanopoda bidentata*, G. O. Sars.
Euphausia pellucida, pars, G. O. Sars.
Euphausia pellucida, Holt & Tattersall.

Fath.	0.	21 *i*	24, 10–15 mm.
,,	,,	22 *d*	1, 7 mm.
,,	,,	22 *e*	2, 7–8 mm.
,,	,,	22 *g*	15, 6–14 mm.
,,	,,	33 *a*	2, 11 mm.
,,	,,	33 *b*	1, 15 mm.
,,	25–0.	30 *m*	4, 5–12 mm.
,,	,,	31 *a*	9, 12–15 mm.
,,	,,	33 *e*	3, 8–10 mm.
,,	,,	33 *g*	15, 8–12 mm.
,,	,,	34 *a*	16, 8–10 mm.
,,	,,	36 *c*	7, 10–13 mm.
			1, 26 mm.*
			3, not measured.
,,	50–0.	25 *k*	1, 11 mm.
,,	,,	30 *l*	32, 8–18 mm.
			1, 25 mm.
,,	,,	31 *b*	250 ca., not measured.
,,	,,	32 *a*	4, 12 mm.
,,	,,	33 *f*	12, 8–15 mm.
,,	,,	36 *d*	3, 10–12 mm.
			1, not measured.
,,	75–0.	32 *m*	16, 5–14 mm.
,,	,,	32 *o*	5, 12–14 mm.
,,	,,	33 *h*	27, 8–15 mm.
,,	,,	34 *c*	5, 10–13 mm.
			4, not measured.
			1, fragment.
,,	,,	35 *a*	9, 8–12 mm.
			2, not measured.
,,	,,	35 *c*	3, 8–12 mm.
			1, not measured.
,,	,,	36 *a*	5, 10–12 mm.
Fath.	100–0.	21 *l*	1, 10 mm.
,,	,,	30 *g*	1, l. Late *Furcilia*, 6 mm.
,,	,,	30 *h*	3, l. *Furcilia*, 5–6 mm.
,,	,,	32 *n* † ..	11, 5–12 mm.
,,	,,	32 *p*	6, 12–15 mm.
			5, not measured.
,,	,,	33 *d*	7, 10–14 mm.
,,	,,	34 *b*	3, 10–12 mm.
			2, not measured.
,,	,,	34 *d*	1, 11 mm.
			2, not measured.
,,	,,	35 *b*	3, 12–15 mm.
			5, not measured.
,,	,,	35 *d*	3, 8–10 mm.
			1, not measured.
,,	,,	35 *x*	3, 6–8 mm.
,,	,,	36 *b*	5, 11–13 mm.
			7, not measured.
,,	150–0.	36 *f*	2, l. *Cyrtopia*, 6 mm.
,,	200–0.	21 *a*	4, 7–10 mm.
,,	,,	36 *g*	2, 10 mm.
,,	200–100.	35 *m*	5, 5–10 mm.
,,	,,	35 *n*	1, fragment.
,,	250–0.	36 *h*	1, 10 mm.
,,	,,	36 *i*	8, 7–14 mm.
			4, not measured.
,,	250–150.	35 *o*	1, 10 mm.
,,	,,	35 *p*	10, 8–13 mm.
,,	300–0.	36 *k*	1, 13 mm.
			1, not measured.
,,	350–0.	36 *l*	2, not measured.
,,	1000–750.	23 *a*	1, 11 mm.
,,	1250–0.	27 *a*	6, 9–12 mm.

* This is the largest known example of the species.
† Includes *n'*.

The larvæ, "l,' mentioned in the above list are only the larger forms which can easily be referred to this species. The collection comprises a number of small larvæ and ova, probably belonging to *E. Mülleri*.

Thysanopoda microphthalma ?, G. O. Sars.

Fath.	75–0.	32 *o*	1, l. *Furcilia*, 5 mm.
,,	100–0.	32 *n*	1, l. *Furcilia*, 5 mm.
Fath.	100–0.	32 *p*	1, l. *Cyrtopia*, 6 mm.

The above are large larvæ which have nearly attained the perfect form. Younger larvæ may be present in the collection, but have not yet been determined.

MEGANYCTIPHANES NORVEGICA (M. Sars).

Synon.: *Thysanopoda norvegica*, M. Sars.
Nyctiphanes norvegica, G. O. Sars *et auct.*
Meganyctiphanes norvegica, H. & T.

Fath.	25–0.	33 *g*	4, 19–28 mm.
,,	,,	36 *c*	12, 25–30 mm.
,,	50–0.	25 *k*	2, 25–27 mm.
			2, exuviæ, *ca.* 30 mm.
,,	,,	30 *l*	1, 30 mm.
,,	,,	36 *d*	1, 22 mm.
,,	75–0.	32 *m*	2, 20–26 mm.
			1, exuviæ.
,,	,,	32 *o*	20, 22–35 mm.
,,	,,	33 *h*	1, 26 mm.
Fath.	75–0.	34 *c*	1, remains. Exuviæ?
,,	100–0.	32 *n*	7, 24–30 mm.
			1, exuviæ, *ca.* 30 mm.
,,	,,	32 *p*	25, 22–30 mm.
,,	,,	34 *b*	1, 24 mm.
,,	,,	34 *d*	9, 23–31 mm.
,,	,,	35 *b*	1, 28 mm.
,,	,,	36 *b*	2, 24 mm.
			2, 30 mm.

THYSANOËSSA GREGARIA, G. O. Sars.

Fath.	100–0.	32 *n*	2, l. nearly adult.

Caullery* has recorded *T. neglecta* from 935 fathoms in the Bay of Biscay. The record is somewhat remarkable, as the species is otherwise known only as a northern form, and one which does not appear to range very far from shore nor into water of more than a few hundred fathoms (compare p. 106).

NEMATOSCELIS MEGALOPS, G. O. Sars.

Fath.	0.	22 *g*	1,10 mm.
,,	,,	33 *b*	1, 24 mm.
,,	25–0.	26 *a*	1, damaged.
,,	,,	31 *a*	1, 9 mm.
,,	,,	33 *g*	9, 12–17 mm.
			3, not measured.
,,	,,	34 *a*	4, 10 mm.
			1, not measured.
,,	,,	36 *c*	4, 13–18 mm.
,,	50–0.	25 *k*	2, 8 mm.
			26, 14–18 mm.
			1, l. 5 mm.
,,	,,	30 *d*	10, 8 mm.
,,	,,	30 *l*	35, 7–11 mm.
,,	,,	31 *b*	90, 4–8 mm.
,,	,,	33 *f*	4, not measured.
,,	,,	36 *d*	3, 18 mm.
			2, not measured.
,,	75–0.	30 *f*	3, not measured.
,,	,,	32 *m*	5, 5–9 mm.
			12, 12–20 mm.
,,	,,	32 *o*	1, l.
			25, 16–22 mm.
,,	,,	33 *h*	2, 14 & 17 mm.
Fath.	75–0.	34 *c*	15, 15–18 mm.
			11, not measured.
,,	100–0.	24 *b*	3, 9–10 mm.
,,	,,	24 *d*	1, not measured.
,,	,,	25 *d*	1, l.
			1, 12 mm.
,,	,,	32 *n*	1, 7 mm.
			12, 14–16 mm.
,,	,,	32 *p*	31, 14–20 mm.
,,	,,	33 *d*	1, 9 mm.
,,	,,	34 *b*	19, 11–22 mm.
,,	,,	34 *d*	1, l.
			15, 10–20 mm.
,,	,,	35 *d*	1, not measured.
,,	,,	35 *x*	1, 18 mm.
,,	,,	36 *b*	5, 18 mm.
,,	150–50.	21 *p*	1, 13 mm.
,,	200–100.	34 *h*	1, 13 mm.
,,	300–0.	36 *k*	1, l.
,,	400–300.	21 *k*	1, not measured.
			1, 25 mm.
			3, damaged.
,,	750–500.	22 *b*	1, 9 mm.

The records of larvæ of this species in the above list are not intended to deny the presence of other larvæ of *N. megalops* in the collections. Of adult forms there are a

* "Campagne du Caudan," Ann. Univ. Lyon, 1896.

few damaged "hulls" without appendages, which may belong to this or another species of the *Nematoscelinæ* subfamily; they are not otherwise mentioned in this paper, as their specific determination, if it were possible, would not affect the evidence of the vertical distribution of any of the species to which they might belong.

Nematobrachion boöpis (Calman).

Synon.: *Nematodactylus boöpis*, Calman.

Fath.	100–0.	32 *p*	1, 21 mm.
,,	200–0	36 *g*	1, 14 mm.
,,	250–0.	36 *h*	1, 20 mm.
,,	250–150.	35 *p*	1, 14 mm.
Fath.	300–0.	36 *k*	1, not measured.
,,	350–0.	36 *l*	1, 18 mm.
,,	500–250.	29 *a*	1, damaged.
,,	1250–0.	27 *a*	1, damaged.

Stylocheiron Suhmii, G. O. Sars.

Synon.: *S. longicorne*, G. O. Sars.
S. mastigophorum, Chun.

Fath.	0.	22 *d*	2, l.
,,	,,	33 *a*	1, l.
,,	,,	33 *b*	2, 8 mm.
,,	25–0.	31 *a*	3, 5 mm.
,,	,,	32 *e*	2, l.
,,	,,	33 *e*	3, l.
,,	,,	33 *g*	8, l.
,,	,,	34 *a*	5, l.
,,	,,	34 *g*	2, l.
			2, small, not measured.
,,	,,	35 *w*	3, l.
,,	,,	36 *c*	1, l.
,,	50–0.	21 *g*	8, l.
,,	,,	25 *e*	23, l.
,,	,,	25 *g*	20, l.
,,	,,	25 *k*	22, l.—8 mm.
,,	,,	26 *e*	18, l.—6 mm.
,,	,,	30 *d*	44, l.
			1, not measured.
,,	,,	30 *l*	10, l.
,,	,,	31 *b*	19, l.
,,	,,	32 *a*	11, l.
			1, 8 mm.
,,	,,	32 *h*	12, l.
			24, 6 9 mm.
,,	,,	33 *c*	2, not measured.
			24, l.
,,	,,	33 *f*	1, l.
			3, 5–7 mm.
,,	,,	36 *d*	3, l.
			23, 5–9 mm.
,,	75–0.	30 *f*	39, l.
			36, 5–9 mm.
,,	,,	32 *g*	8, l.
			2, 5–6 mm.
Fath.	75–0.	32 *m*	30, l.—12 mm.
,,	,,	32 *o*	2, l.
			28, 4–10 mm.
,,	,,	33 *h*	5, 8–9 mm.
,,	,,	34 *e*	24, l.
			30, 4–9 mm.
,,	,,	35 *a*	10, 6–8 mm.
,,	,,	35 *c*	1, l.
			8, 6–8 mm.
,,	,,	35 *e*	3, l.
,,	,,	35 *y*	2, l.
			5, 6–8 mm.
,,	,,	36 *a*	6, l.
			5, 5–8 mm.
,,	100–0.	21 *d*	1, 7 mm.
,,	,,	21 *h*	7, l.—7 mm.
,,	,,	21 *l*	1, l.
,,	,,	22 *a*	2, l.
,,	,,	24 *b*	20, l.—8 mm.
,,	,,	24 *d*	5, 8 mm.
,,	,,	24 *e*	2, 7 mm.
,,	,,	25 *d*	10, l.—6 mm.
,,	,,	30 *g*	2, l.
			2, 5 mm.
,,	,,	30 *h*	12, l.
			4, 8–10 mm.
,,	,,	32 *d*	2, l.
			1, 8 mm.
,,	,,	32 *i*	7, l.
			1, 8 mm.
,,	,,	32 *n*	20, l.—10 mm.
,,	,,	32 *p*	7, l.
			35, 4–9 mm.
,,	,,	33 *d*	1, 9 mm.
,,	,,	34 *b*	31, l.

Fath.	100-0.	34 *b*	33, l.—9 mm.
„	„	34 *d*	5, l.
			52, 5–8 mm.
„	„	35 *b*	16, 6–10 mm.
„	„	35 *d*	2, l.
			3, 6–8 mm.
„	„	35 *f*	1, l.
			1, 11 mm.
„	„	35 *x*	10, l.—8 mm.
„	„	36 *b*	2, l.
			11, 5–7 mm.
„	„	36 *e*	2, l.
			3, 7–10 mm.
Fath.	150-0.	36 *f*	5, l.
			2, 8 mm.
„	150–50.	21 *p*	1, 9 mm.
„	200-0.	36 *g*	3, 8 mm.
„	250-0.	36 *h*	2, l.
			3, 5–8 mm.
„	„	36 *i*	3, l.
			1, 6 mm.
„	300-0.	36 *k*	2, l.
			1, 8 mm.
„	350-0.	36 *l*	12, l.
„	300–200.	21 *c*	3, l.
„	1250-0.	27 *a*	5, l.—8 mm.

The above list includes all the larvæ in the collection, and in this respect is comparable only to the list of *S. abbreviatum*.

STYLOCHEIRON ABBREVIATUM, G. O. Sars.

Synon.: *Stylocheiron chelifer*, Chun.
Stylocheiron abbreviatum, Ortmann.

Fath.	75-0.	32 *m*	3 l.
			4 (l. or small, not measured).
		„	1, 7·5 mm.
		„	1, 18 mm.
„	„	32 *o*	5, l.
„	„	35 *a*	2, 10 mm.
„	„	36 *a*	1, 10 mm.
„	100-0.	22 *a*	1, 10 mm.
„	„	24 *b*	2, 6–9 mm.
		„	1, fragment.
Fath.	100-0.	32 *n*	1, l.
„	„	32 *p*	1, 18.
„	„	33 *d*	1, 17 mm.
			1 (not measured).
„	„	34 *b*	1, l.
„	„	35 *b*	1, 12 mm.
„	„	35 *d*	1 (not measured).

All the larvæ in the collection are listed above. The generic characters are apparent from a very early stage, and specific differentiation from *S. Suhmii* is easy on account of the difference in size.

BENTHEUPHAUSIA sp.

Fath. 1250–0. 27 *a* ..... 1, damaged, 8 mm.

EUCOPIA UNGUICULATA (Will.-Suhm).

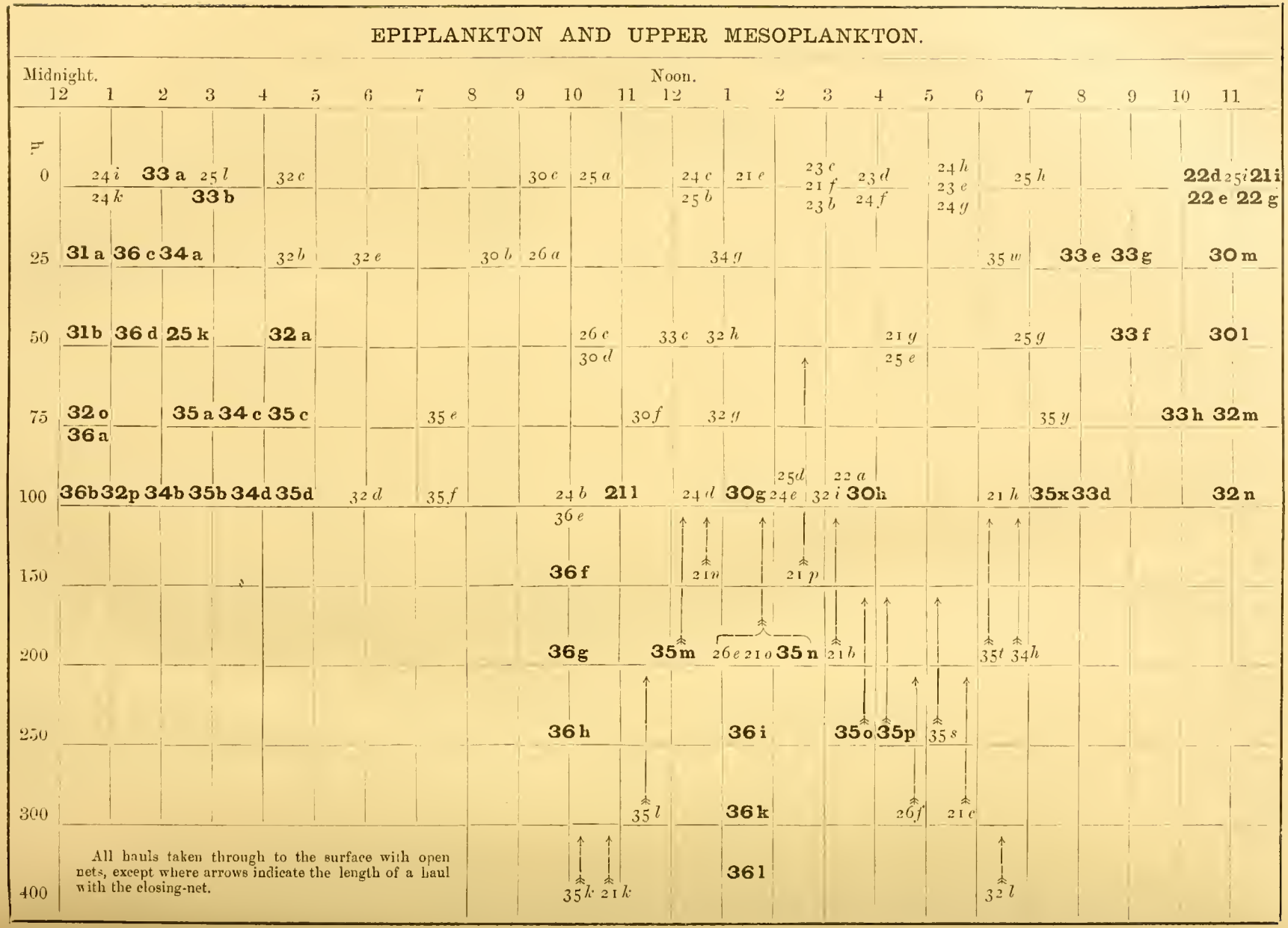
Fath.	200–100.	21 *o*	1, fragment.
„	350-0.	36 *l*	1, 15 mm.
„	400–300.	21 *k*	2, 14–20 mm.
„	„	35 *k*	1, 15 mm.
Fath.	750–500.	22 *b*	1, 12 mm.
„	1250-0.	27 *a*	1, 26 mm.
		„	1, fragment.
„	1500–750.	30 *a*	2, 14–20 mm.

EUCHÆTOMERA FOWLERI, H. & T.

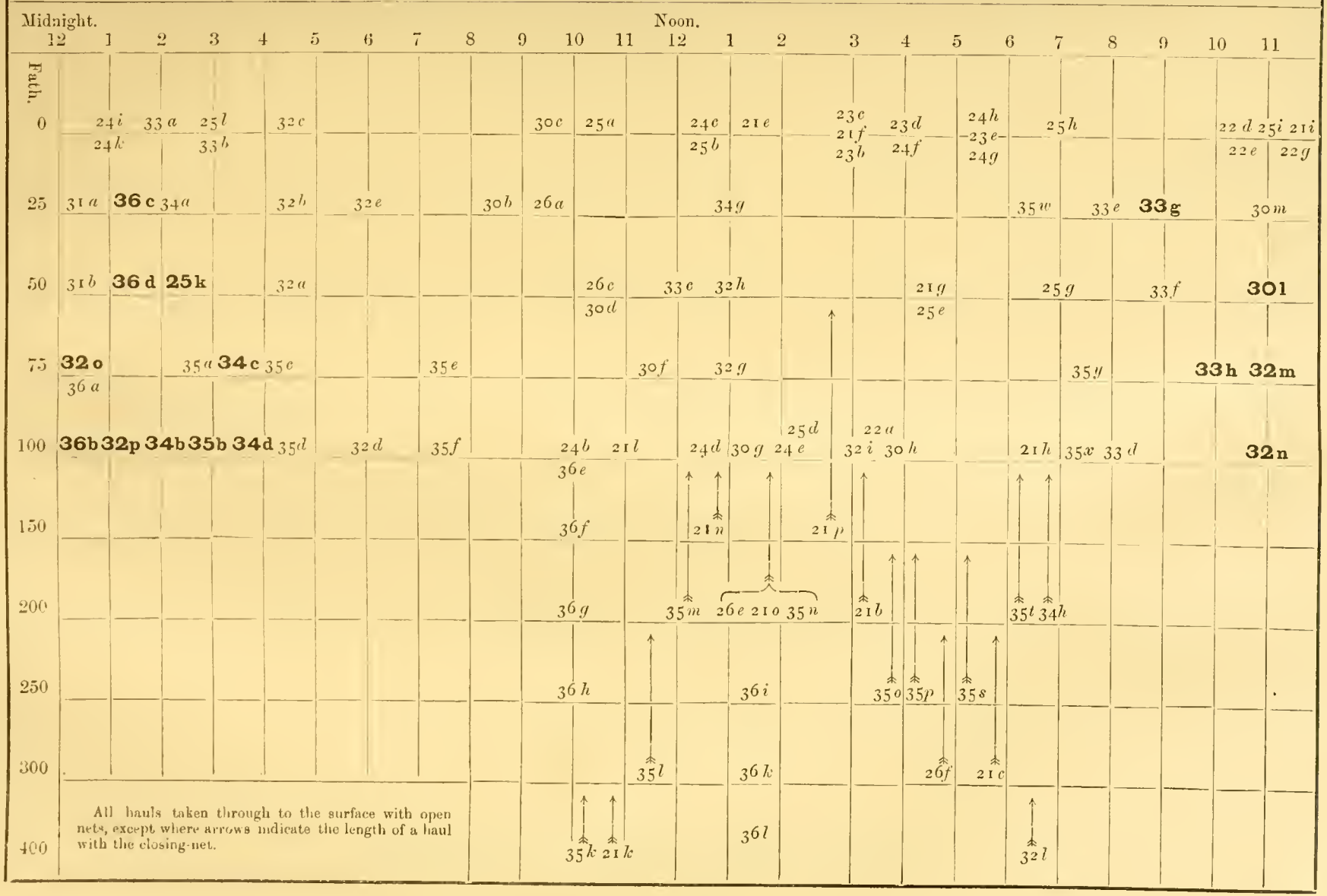
Fath.	200-0.	36 *g*	1, ♀ 11 mm.
Fath.	250-0.	36 *h*	1, ♂ 10 mm.

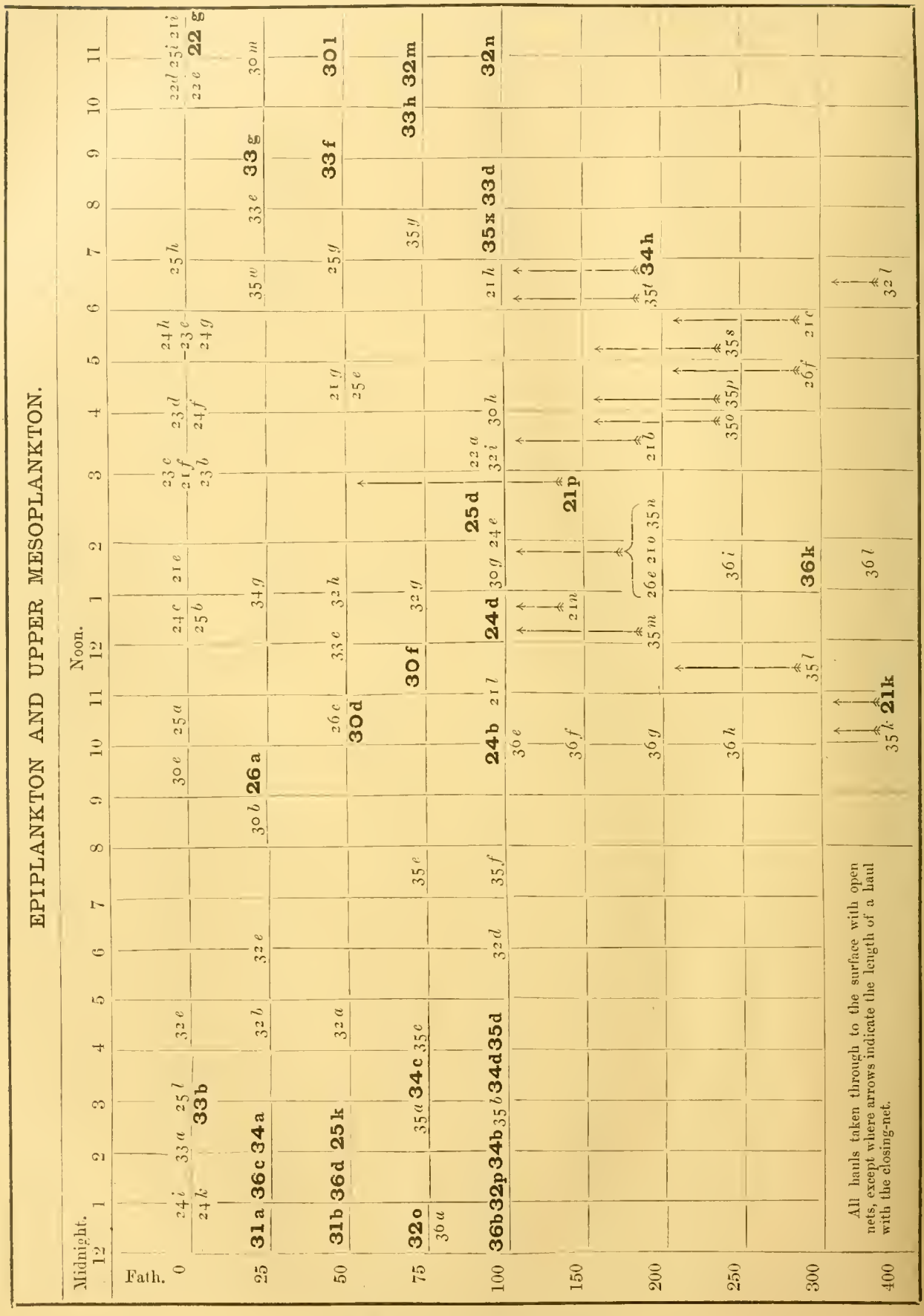
NOTE ADDED IN PRESS.—The manuscript left our hands before the appearance of Dr. Hansen's papers, Nos. 30 and 42 of the 'Bulletin du Musée Océanographique de Monaco.' Imperfection of reference to these papers must therefore be ascribed to the exigencies of pagination.

EPIPLANKTON AND UPPER MESOPLANKTON.



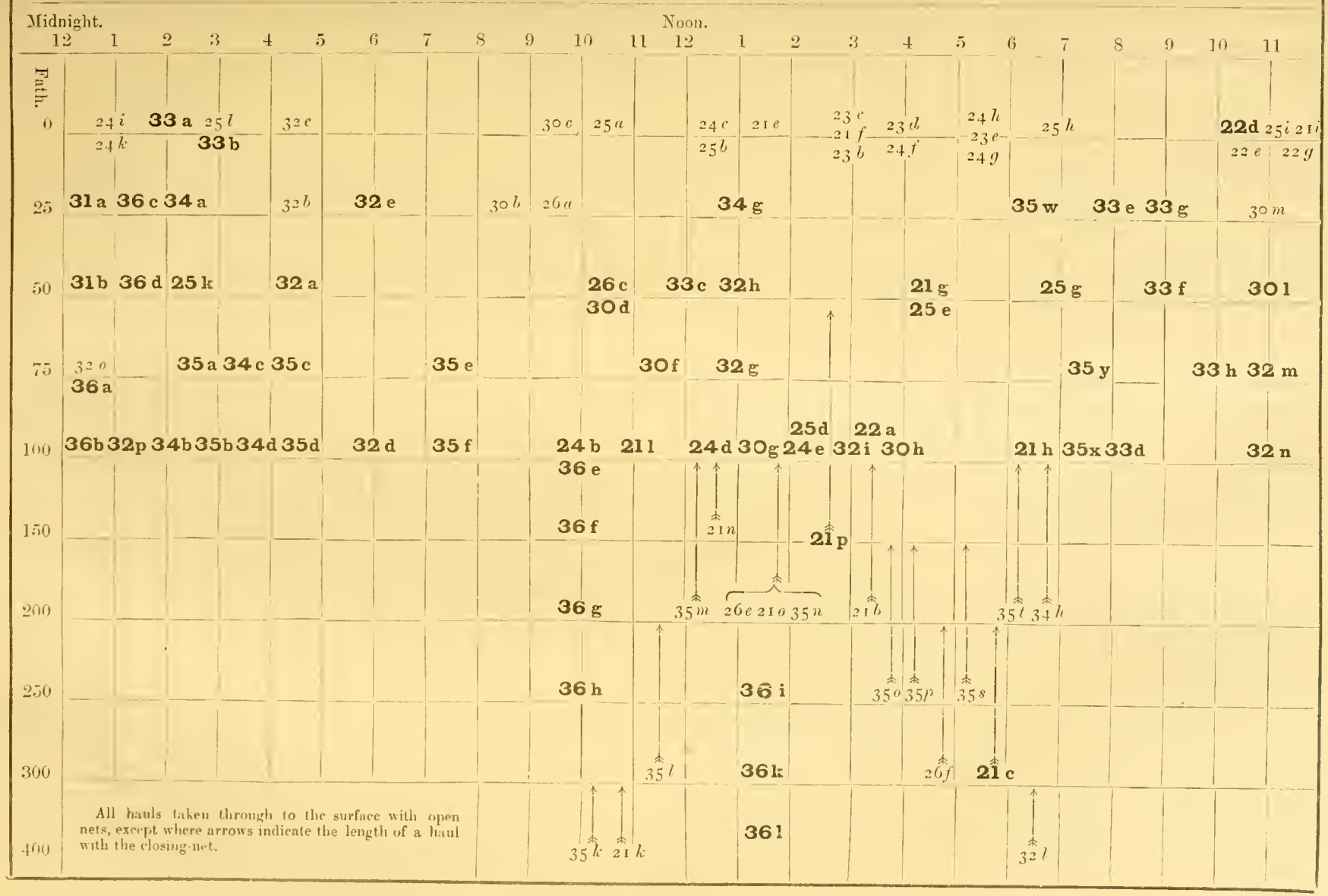
EPIPLANKTON AND UPPER MESOPLANKTON.





NEMATOSCELIS MEGALOPS.

EPIPLANKTON AND UPPER MESOPLANKTON.



APPENDIX ON THE VERTICAL DISTRIBUTION AND MOVEMENT OF THE SCHIZOPODA.

By G. Herbert Fowler.

I have added these few notes to the foregoing paper in order to bring the results into line for comparison with those which are being obtained in other groups of the collection. In particular, the tables of averages seem to me to be important from the point of view of the reader, because (for example) although the time-depth tables on pp. 118–121 give through the eye a general idea of the distribution of a species as regards the upper strata, they give no idea of the comparative numbers present; further, the hauls having been of varying duration and made with nets of varying mesh (both of which were mistakes), a common standard is required for the real appreciation of their meaning, certain hauls must be omitted as misleading, and so forth.

Euphausia Müllери.

A reference to the General Table of Distribution (p. 112) shows that this species was well represented in the Epiplankton, at any rate at certain hours. Below 100 fathoms it occurred occasionally in the closing-nets 200–100 and 250–150 fathoms. It was not taken by any of the 25 hauls which closed below 250 fathoms, with the exception of a single specimen in 23 *a* (1000–750 fathoms); as it failed between 250 and 750 fathoms, I venture to differ from Messrs. Holt and Tattersall in thinking that it probably is not to be found alive much below 250 fathoms *.

The captures with comparable nets are analysed in the following table †, which should be read as a sentence from left to right :—

In open nets towed at	fathoms, this species occurred in	per cent. of the hauls, with	average specimens per hour haul.
0	25	5·1	
25	50	4·0	
50	46	4·1‡	
75	63	8·1	
100	54	3·1	
150	1	1·0	
200	1	1·0	
250	2	3·5	
300	1	1·0	
350	1	1·0	
Between	hauls, with		average specimens per 100 fm. haul.
200–100	2	0·8	
250–150	2	3·6	

* Its occurrence in 27 *a'*, and 36 *f*, *g*, *h*, *i*, *k*, *l*, being all nets open to the surface, give no reliable indication of its depth-limits.

† In this Appendix, some Schizopods have been treated statistically in the same manner as were the Chætognaths of a previous paper. "Average specimens" have been averaged over all hauls, whether the species occurred in them or not; nine surface-hauls with a mesh of .180 per linear inch have been omitted, as failing to capture strong swimmers. The actual numbers recorded by Messrs. Holt and Tattersall have been treated where necessary with a time-factor to bring them to the standard one-hour haul.

‡ The rich haul of 31 *b* (11.30 P.M. to 12.30 A.M.), which also caught an unusual number of *Nematoscelis megalops*,

On the question of a vertical oscillation, as Messrs. Holt and Tattersall have already pointed out (p. 109), the table on p. 118 seems to indicate a nocturnal rise and diurnal fall of this species. But it seems worth while to present the evidence for this view in the form of statistical tables in the same manner as has been adopted for *Sagitta serratodentata* (p. 60), a case in which the reverse oscillation appeared to hold good *. The following table shows the average catch per hour haul by "day" and "night"; the dawn, about 3.0 A.M., and dusk, about 7 P.M., are the most convenient dividing hours; but if 4.0 A.M. be taken instead of 3.0 A.M., allowing time for the species to sink after dawn, the contrast is even more marked, and the method is probably more in accord with the facts.

Depth in fathoms.	4.0 A.M. to 7.0 P.M.		7.0 P.M. to 4.0 A.M.	
	Number of hauls.	Average specimens per hour.	Number of of hauls.	Average specimens per hour.
0.....	9	0	7	11·7
25.....	6	0	6	9·5
50.....	8	0·5	4	12·5†
75.....	3	0	8	11·2
100.....	13	0·3	9	7·2

The arrangement of the captures according to the light-intensity as tested by a photographer's actinometer, which gave no results in the case of *Sagitta serratodentata*, confirms the idea of the oscillation of *Mülleri*, and indicates that the movement affects the upper 100 fathoms a little before dusk and after dawn. In the next table, which illustrates this point, the hauls were arranged according as the actinometer assumed the standard tint at 2″, 3″–6″, 7″–10″, 11″ to dusk or dawn; the remaining hauls being

was evidently made under abnormal circumstances, and sends up the values for 50 fathoms in all the tables to a disproportionate extent. My log records "beginning to blow, some rain" about midnight, and it is barely possible that the weather concentrated at 50 fathoms specimens which normally would have been at higher levels at that hour. The number caught was so abnormal that the haul has been omitted from the tables of *E. Mülleri* and *N. megalops*, the values obtained by its retention being, however, recorded in footnotes; if included in this table, the average specimens at 50 fathoms would be 23·3.

* As this species, unlike *serratodentata*, was only found at the surface at night, and the hauls "during or after rain" were all in daylight, the latter are not shown separately from the rest.

† If haul 31 *b* be included, 5 hauls yielded an average of 60·0! The single haul at 50 fathoms which showed specimens in daylight was 32 *a*, 4.15 to 5.15 A.M.

grouped as "night"; the numbers at the various depths are average specimens per hour haul, the absence of observations being indicated by a plus sign:—

Fathoms.	2″.	3″–6″.	7″–10″.	11″ to D.	Night.
0	0	0	0	0	11·7
25	+	0	0	0	8·0
50	+	0	0	2·0	13·5 *
75	+	0	0	7·2	15·2
100	0	0 6	0	4·4	8·6

It is noticeable that a bright moon did not seem to drive the species from the surface (compare captures at 21 *i*, 22 *g*); the average capture per hour in bright moonlight was 13·3.

The foregoing tables show pretty clearly the oscillation of this species by statistical methods. The question may pertinently be put,—where was the species to be found by day? The answer to this unfortunately cannot be deduced with certainty from my collections.

Three hauls out of thirteen at 100 fathoms between 4.0 A.M. and 7.0 P.M. produced five specimens, which work out to an average of 0·3 specimens per hour haul: still, what may have been the upper fringe of the species was at or about 100 fathoms during the day, so far as my hauls go.

The seven serial two-hour hauls (36 *e*, *f*, *g*, *h*, *i*, *k*, *l*) only caught 21 specimens among them (absolute untreated numbers), giving an average of 1·5 specimens per hour haul, which is surprisingly low.

But it is noticeable that at 250 fathoms one serial tow-net (36 *i*) caught as many as 12 specimens (6 per hour), and that the closing-nets 35 *m* and 35 *p* caught respectively 5 and 10 specimens per 100 fathom haul; in other words, these closing-nets produced one specimen for every cube of (approximately) $5\frac{1}{2}$ feet and 7 feet which they respectively filtered. This indicates the presence of a fairly large population between 250 and 100 fathoms in daylight.

MEGANYCTIPHANES NORVEGICA.

This species was taken solely at or between 25 and 100 fathoms.

At	fathoms, it occurred in	per cent. of the hauls, with	average specimens per hour haul.
0	0	0	0
25	25	30	5·0
50	30	36	1·8
75	36	27	4·1
100	27		2·2

It occurred in only 20 per cent. of the total hauls at or between 25 and 100 fathoms. Owing to its comparative scarcity, conclusions drawn from its distribution during the cruise would be unconvincing.

* If haul 31 *b* were included, this figure would be 60·0.

The distribution of the species during day and night is shown in the following table for comparison with the other common species :—

Depth in fathoms.	4.0 A.M. to 7.0 P.M.		7.0 P.M. to 4.0 A.M.	
	Number of hauls.	Average specimens per hour haul.	Number of hauls.	Average specimens per hour haul.
0	9	0	7	0
25	6	0	6	10·1
50	8	0	5	4·8
75	3	0	8	6·6
100	13	0	9	5·4

As Messrs. Holt and Tattersall point out, the failure to capture *a single specimen at any depth whatsoever* during daylight is most curious, and must be left unexplained for the present.

NEMATOSCELIS MEGALOPS.

The vertical distribution of this species was apparently very similar to that of *Euphausia Mülleri*.

	Depth in fathoms.	Number of fathoms, this species occurred in	Per cent. of the hauls, with	Average specimens per hour haul.
In open nets towed at	0	12		0·2
	25	41		1·9
	50	46		6·6
	75	45		6·2
	100	50		3·8
	150	0	0	0
	200	0	0	0
	250	0	0	0
	300	1	1	1
	350	0	0	0
In closing-nets between	150–50	1	1	1
	200–100	1	1	1
	300–200	0	0	0
	400–300	1	5	5
	500–400	0	0	0
	750–500	1	1	1

From this table* it is apparent that the centre of distribution lay about 50 and 75 fathoms; it occurred in only 13 per cent. of the 23 hundred-fathom sections with the closing-net between 750 and 100 fathoms, with an average of 0·3 specimens per 100 fathoms.

It is possible, as Messrs. Holt and Tattersall suggest, that this species exhibits a diurnal fall and nocturnal rise like *Euphausia Mülleri*, but neither the time-depth

* If haul 31 *b* were included (compare p. 122, note) the average specimens per hour at 50 fathoms would have been 13·0.

table (p. 120) nor the table of average specimens per hour haul immediately following shows it so obviously as in the other case.

Depth in fathoms.	4.0 A.M. to 7.0 P.M.		7.0 P.M. to 4.0 A.M.	
	Number of hauls.	Average specimens per hour haul.	Number of hauls.	Average specimens per hour haul.
0	9	0	7	0·5
25	6	0·1 *	6	3·6
50	8	0·7 *	4 †	18·5 †
75	3	1·0 *	8	8·0
100	13	0·4	9	7·5

The most that one dare say is, that the species was less commonly caught in daylight than at night.

STYLOCHEIRON SUHMII.

The table below shows that, while the species occurred in every haul at 50, 75, and 100 fathoms, the expectation of specimens was highest at 50 and 75 fathoms.

In open nets towed at	fathoms, this species occurred in	per cent. of the hauls, with.	average specimens per hour haul.
0	12	0·5	
25	66	2·4	
50	100	21·5	
75	100	22·6	
100	100	13·9	
150	1	1 A, 3 L	
200	1	1 A	
250	2	1·5 A, 1 L	
300	1	1 A, 1 L	
350	1	0 A, 6 L	
Between 150–50	1	1 A	average specimens per 100 fm. haul.
200–100	0	0	
300–200	1	1 L	

The evidence of this table appears to point to this species having been epiplanktonic. In the open serial nets, I have shown adults (A) and larvæ (L), because, as will be seen from the next table, the expectation of larvæ diminishes with depth; and if these larvæ be subtracted as possibly dead and sinking, the remaining adults are not more than might be expected to be captured in the upward passage of an open net through densely populated strata. A few specimens may have penetrated beyond the 100-fathom horizon, but the centre of distribution was doubtless the lower epiplankton between 50 and 100 fathoms.

Omitting the surface hauls, which contained only eight (4 A and 4 L) specimens in all, captured in two out of sixteen hauls, and are therefore too few to carry any weight in

* Bright daylight, actinometric standard reading 3″–6″.

† If 31 *b* were included, 5 hauls at night would yield 32·8 average specimens.

this connection, it appears that the expectation of larvæ diminished with depth, that of adults increased with depth: the average catches per hour haul consisted

At 25 fathoms of 93 per cent. larvæ and 6 per cent. adults.
50 „ „ 73 „ „ „ 26 „ „
75 „ „ 34 „ „ „ 65 „ „
100 * „ „ 20 „ „ „ 79 „ „

The next table presents the distribution of adults, of larvæ, and of both taken together, at various depths by "day" and "night" (as in previous cases), in average catches per hour haul. It shows no evidence of a nocturnal rise of the species; but it presents some puzzling features.

Depth in fathoms.	4.0 A.M. to 7.0 P.M.				7.0 P.M. to 4.0 A.M.			
	Hauls.	Adults.	Larvæ.	Together.	Hauls.	Adults.	Larvæ.	Together.
0	9	0	0	0	7	0·5	0·5	1·1
25	6	0·3	1·1	1·5	6	0·0	3·3	3·3
50	8	3·3	21·4	24·8	5	9·6	6·6	16·2
75	3	12·6	16·6	29·3	8	15·5	4·2	20·0
100	13	2·1	3·0	5·1	9	22·0	2·3	24·3

One of these is that so many more adults were caught by night than by day at 75 and 100 fathoms—depths at which it is difficult to think that the light is strong enough to enable the species to see and avoid a net; and a remarkable feature is that these large night values were mainly due to three hauls (34 *b*, *c*, *d*), all taken on one night within two hours. In *Euphausia Mülleri* and *Nematoscelis megalops* some undetermined circumstances (p. 122, note) had concentrated these species at 50 fathoms at the time when haul 31 *b* was made, but in that haul *Stylocheiron Suhmii* was not remarkably plentiful; in 34 *b*, *c*, *d*, when the latter was abundant, no such marked increase in the number of the other two species was noticeable. Whatever the determining stimuli may have been, it is fairly obvious that they were not the same in the two cases; I have no explanation of the facts to offer; no entry in the log suggests a clue in the second case; but I record the observation here to show how difficult it is to get any knowledge of the factors of distribution, and (incidentally) how dangerous it is to generalise from isolated hauls, or from one species to another. Precisely on the same footing, the higher values for larvæ by day than by night are mainly due to two hauls (30 *d* and 30 *f* †),

* Omitting 24 *b*, where the comparative number of larvæ and adults had been lost.

† The latter included also a considerable number of adults.

taken within two hours and a quarter; in this case it is just worth notice that they were morning hauls after a night of very heavy rain and thunder.

In this connection it would be worth the while of future observers to consider whether the mere presence of a ship hove-to does not, after a time, concentrate certain species: the offal of a ship is very considerable, and means a sudden enhancement of the food-supply, which might perhaps account for some of the apparent variations in population. The hauls 31 *b*, 34 *a*, *b*, *c* were all made after a considerable period of laying-to.

It may be argued that the proportional catches of larvæ and adults confirm the idea that adult Schizopods can see and avoid (or swim out of) the net in daylight, and hence are caught more plentifully by night, while the larvæ, moving more slowly, would naturally be caught more abundantly in the day than adults. But if this were the sole explanation, larvæ ought to have been captured equally plentifully by day and by night, whereas they were absolutely (not relatively) taken in far greater numbers in daylight. Besides, as Messrs. Holt and Tattersall point out, *S. Suhmii* must be a feeble swimmer, if only in consequence of the length of some appendages.

The idea that even large Schizopods can (except possibly at the surface) see a net and avoid it is not easy to grasp. Those of us who have tried to pick up white plates, or chalk eggs, in even a few feet of water, know how rapidly the light diminishes in those few feet. At 100 fathoms the experiments of Fol and Sarasin do not seem to demonstrate the presence of more than a twilight of actinic rays; the red and yellow rays are stopped in a comparatively short passage through sea-water. It may be urged, and is quite possible, that the eyes of Schizopoda can appreciate rays invisible to our eyes: Moseley suggested many years ago that the large eyes of some abyssal forms might "see" the heat-rays given off by other organisms. But if ordinary light and vision can help a Schizopod to escape capture, surely a brilliantly phosphorescent net by night must be a more conspicuous object * than the same net used by day at any depth beyond 25 fathoms; and, further, in such cases as the three plentiful Schizopods tabled above which extend to 100 fathoms, the captures at that depth during daylight should approximate to those at the same depth during night, the light there being so small, and the phosphorescence presumably as brilliant as at the surface; at least, more should be captured at 75 than at 50 fathoms, more at 100 than 75 fathoms, yet this is not the case (compare tables, p. 127, adults).

It seems to me to be more probable that strong swimmers, such as Amphipoda and Schizopoda, are actually caught in the ordinary slowly-moving tow-net, but in daylight make for the brighter end of it—the mouth—exactly as a bee in a room makes for the window. It is in the experience of every tow-netter that a wide-meshed net †, which allows of a faster current through it, catches more of such organisms than a fine-meshed net, in which the current is reduced. But I doubt if this accounts for all the facts; it

* Mr. Holt tells me that the reason that bright moonlight is good for mackerel-fishing is alleged to be that the phosphorescent nets are less conspicuous in the bright light.

† We failed to tow-net advanced lobster larvæ at Plymouth till a wide-meshed net was used at a comparatively rapid pace.

may account for the failure to take *Meganyctiphanes norvegica* by day, but it does not, to my thinking, explain away the apparent nocturnal rise of *Euphausia Mülleri*.

Summary.

The following conclusions, relative to the more plentiful species, refer, of course, only to the area studied and to the time of the cruise. They are not necessarily, many of them not even probably, true for distant localities under different conditions.

None of the species captured throw any light on the population of the Mesoplankton; all those taken in any quantity were essentially epiplanktonic. But *Euphausia Mülleri* ranged as deep as 250–150 fathoms, *Nematoscelis megalops* doubtfully to 400–300 fathoms. *Eucopia unguiculata*, a purely mesoplanktonic form, occurred as high as 200–100, and as low as 750–500 fathoms.

Euphausia Mülleri was essentially epiplanktonic, with a centre of distribution at about 50 to 75 fathoms. It appeared to descend in small numbers as far as 250–150 fathoms. At the surface and 25 fathoms it was captured only by night, and in large numbers by moonlight: it may be regarded as an instance of a nocturnally rising species.

Meganyctiphanes norvegica, caught comparatively in small numbers and on few occasions, was purely epiplanktonic, and was captured only by night.

Nematoscelis megalops was essentially epiplanktonic, with a centre of distribution at about 50–75 fathoms; a few specimens were caught at greater depths than 100 fathoms. The indications of a nocturnal rise were less well marked than in *Euphausia Mülleri*.

Stylocheiron Suhmii was the species most numerously and most frequently represented in the collections. The centre of distribution lay again at about 50 to 75 fathoms; and it is doubtful whether the species penetrated much below 100 fathoms. The expectation of larvæ diminished, and that of adults increased, with depth down to 100 fathoms: larvæ were captured in greater numbers by day, adults by night. The indications of a nocturnal rise were not strongly marked.

Stylocheiron abbreviatum, taken rarely and in small quantities, was confined to nets towed at 75 and 100 fathoms.

BISCAYAN PLANKTON.

Part VI.—THE COLLOID RADIOLARIA.

By R. Norris Wolfenden, *M.D., F.L.S., F.Z.S.*

Read 1st June, 1905.

The collection handed to me for examination by Dr. G. H. Fowler was contained in 80 bottles. Of these, in a few instances, the material was in a condition difficult of identification. While such species as *Thalassicolla* and *Chœnicosphæra* (in which the shell presents sufficiently distinctive characters) are comparatively easy of determination, it must be borne in mind that the determination of species of *Collozoum* except in the very recent or actually living condition is always a matter of considerable difficulty, often of impossibility, and the diagnosis of such species is here presented with the necessary reserve.

The material to hand contained few species, but an overwhelming preponderance of one of them, viz. *Chœnicosphæra*, which appeared in no less than 67 gatherings.

Collozoum inerme, Haeckel.

Very few intact "sausage-shaped" colonies were found. In most cases the colonies were oval or more or less round and in young condition. One long colony was 15 mm. in length, 1 mm. broad. All trace of segmentation was lost. The closely-packed individuals contained each one central oil-globule, and were of ·045 diameter surrounded by numerous green cells round the zooids. This was the only intact long colony, evidently in the young condition.

In all cases the diagnosis must be regarded as doubtful in the absence of the occurrence of regular segmented and vacuolated colonies and the determination of the behaviour under osmic acid, chromic acid, &c.

Collozoum Brandti, Wolfenden.

A few instances occurred of rounded colonies about 4 mm. diameter, containing zooids of 1 mm. diameter, each with one central oil-globule and 25–30 xanthellæ. The colonies showed no trace of vacuolation. One such colony of about 3·0 mm. diameter contained 700 zooids. In one instance a few diatoms, long and spindle-shaped, were found lying between the zooids, of characters identical with those which I have described as occurring in the *Collozoum* of the Færoe Channel, to which I gave the name *C. Brandti* *. The diagnosis of this species is again given under reserve, but it is undoubtedly not *C. inerme*.

Sphærozoum punctatum ?, Müller.

In only one sample occurred a small colony of this species (not in very good condition).

* Journal Marine Biological Association, vol. vi. p. 344 (1902).

The shanks of the needles, three at each end of the rod, were twice as long as the rod. The length of the central rod was ·025 mm.; that of the shanks was ·05 mm. "*Punctatum*"-needles vary in size and proportions, and though the shanks in this species are commonly shorter than the rod, the Biscayan specimen is probably of this species, though not in good enough condition to determine with absolute accuracy.

Thalassicolla nucleata, Huxley.

From the surface to 100 fathoms this species occurred in 18 cases in Dr. Fowler's samples. The species is too well known to require description.

Chœnicosphæra Murrayana (Haeckel, 'Challenger' Report: Radiolaria).

This is the most commonly occurring Radiolarian in this collection, being present in 67 of the samples. The zooids being often of a rather larger average size than the examples of the same species found in the Færoe Channel, suggested at first a specific difference. I have made a detailed comparison of the Biscayan examples with those from the Færoe Channel, and there seems to be little essential difference between the two.

	Biscayan species.	Færoe species.
Size of colony....	2·6–3 mm.	2–3 mm. or a little over.
Shape.....	Round.	Round.
Shells.....	·17–·24 mm. diameter.	·18–·16 mm. diameter.
Pores.....	Of unequal size. About 30 in the half meridian. ·012–·033 mm. diameter.	Of unequal size. About 30. ·02–·04 mm. diameter.
Corona	Of six spines. No spines between the pores.	Six spines usually. No spines between the pores.

The Biscayan specimens having been preserved for some time showed none of the vacuoles, which are plainly to be recognized in the fresh northern species; and though the shells in some colonies are distinctly larger than the Færoe species seems ever to attain, this is the only difference. The oval or round pores of the shell are very irregular as to size, between three or four large pairs is often interposed a small rounded one; the bars between the pores are not usually broader than half the diameter of the pore, but between a few the bars are occasionally of much greater breadth. The xanthellæ are numerous, and round each zooid is a thick pseudopodia-layer with thick pseudopodia-strands passing between two or three neighbouring individuals. *Chœnicosphæra* is of very frequent occurrence in the Færoe Channel and round the coasts of Shetland, in

which region it is, in my experience, by far the most commonly occurring of the colony-forming Radiolaria, and it appears to be equally common in the Bay of Biscay. The species described by Prof. Cleve as *Trypanosphæra brachysiphon* * from the Atlantic bore such a strong resemblance to *Chœnicosphæra Murrayana* that in 1902 † I suggested the identity. I have latterly forwarded some specimens of the Biscayan species to Prof. Cleve for comparison with his described species, and he has replied to me that they are the same, and that his *Trypanosphæra* is really *Chœnicosphæra Murrayana*. The absence of a tube-process round the pores of course removes the species from the former genus of Haeckel. The elevated ridge bearing the short teeth round the pore is small, it and the spines or teeth not being in height equal to more than half the diameter of the pore.

In the Færoe Channel examples I have been fortunate enough to observe the species in the Isospore stage, but I do not find this stage in Dr. Fowler's specimens.

NOTE TO THE FOREGOING.

By G. Herbert Fowler.

These Colloid Radiolarians are generally regarded as being distinctively surface forms, but an analysis of the captures by no means bears out this idea.

	Collozoum inerme.	*Thalassicolla nucleata.*	*Chœnicosphæra Murrayanum.*	All species together.
At 0 fathoms	36	5	36	52
„ 25 „	25	16	66	75
„ 50 „	46	30	84	84
„ 75 „	18	18	72	72
„ 100 „	40	40	90	95

The table gives, for each depth, the percentage of the hauls at that depth in which the three commonest species were captured, or (in the fourth column) in which one or other of the three species was captured. It shows that while *Collozoum inerme* was fairly evenly distributed, the expectation of capture of the other two species increased with

* K. Sv. Vet.-Akad. Handlingar, Band 34.

† Journal Marine Biol. Assoc. 1902, p. 353 : "The Plankton of the Færoe Channel, &c."

the depth *. In this as in similar tables in the earlier reports the excess of the captures at 50 fathoms over those at 25 and 75 fathoms is puzzling.

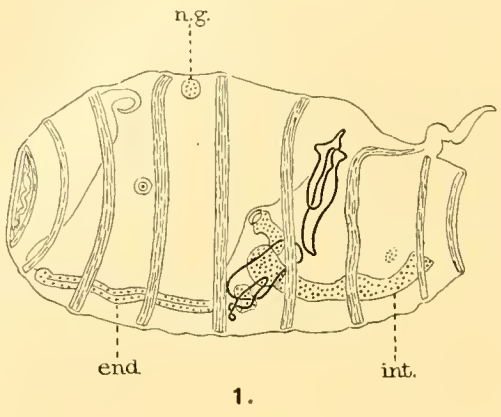
On the other hand, although not essentially surface forms, they were distinctly epiplanktonic, not descending to great depths. The specimens from 21 *a*, and from 36 *f–l*, may have been captured at any point between their extreme depth and the surface, but specimens from the closing-nets, marked F in the table (p. 135), were in all cases few and fragmentary, and were probably dead specimens sinking to the bottom. These Radiolaria probably did not live much below 100 fathoms.

When the occurrences were plotted on "time-depth" tables, or "day, night, and rain" tables, no evidence was forthcoming of any movement of these Radiolaria in response to light, darkness, or rain. For example, *Chœnicosphæra Murrayana* occurred at the surface in 45 per cent. of the "day" hauls, 42 per cent. of the "night" hauls; as it also occurred at the surface in two out of the three "rain" hauls, we may conclude that it does not sink in consequence of wet weather. We know from Prof. Brandt's experiments that *Thalassicolla* can rise and sink with considerable rapidity in response to stimuli, but unfortunately it was not captured sufficiently frequently to give any indications.

* The nine hauls with a net of 180 meshes per linear inch, referred to in previous reports, have again been omitted. That they failed to catch even these Radiolaria, which have no power of swimming, is a fairly conclusive proof of the uselessness of such fine-meshed nets for a general fauna, although doubtless necessary for Coccospheres, Diatoms, and minute Protozoa.

Depth in fathoms.	Haul.	*Collozoum inerme.*	*Collozoum Brandti.*	*Sphærozoum punctatum.*	*Thalassicolla nucleata.*	*Chænicosphæra Murrayana.*
0	21 *e*					
	21 *f*					
	21 *i*	..	..	..	..	+
	22 *d*	+	..	..	+	+
	22 *e*					
	22 *g*	+				
	23 *b*	+	..	..	..	+
	23 *c*					
	23 *d*	+	..	..	..	+
	23 *e*					
	24 *c*					
	24 *f*	+	..	..	..	+
	24 *g*	..	..	..	..	+
	24 *h*					
	24 *i*	+				
	24 *k*					
	25 *a*					
	25 *b*					
	25 *h*					
	25 *i*	+				
	25 *l*					
	30 *c*					
	32 *c*					
	33 *a*					
	33 *b*	..	..	..	..	+
25—0	26 *a*	..	..	..	..	+
	30 *b*	+	..	..	+	
	30 *m*					
	31 *a*					
	32 *b*	..	..	..	..	+
	32 *e*	..	..	..	..	+
	33 *e*	..	..	..	..	+
	33 *g*	..	+	..	..	+
	34 *a*	+	..	..	+	+
	34 *g*					
	35 *w*	..	..	..	..	+
	36 *c*	+	..	..	..	+
50—0	21 *g*	+	..	..	+	+
	25 *e*	..	..	..	..	+
	25 *q*					
	25 *k*	..	..	..	..	+
	26 *c*	..	..	..	..	+
	30 *d*	+	..	+	..	+
	30 *l*	+	..	..	+	+
	31 *b*					
	32 *a*	+	..	..	+	+
	32 *h*	+	..	..	..	+
	33 *c*	+	..	..	+	+
	33 *f*	..	..	..	..	+
	36 *d*	..	..	..	..	+
75—0	30 *f*	..	..	..	+	+
	32 *g*	+	..	..	..	+
	32 *m*					
	32 *o*					
	33 *h*					
	34 *c*	..	..	..	..	+
	35 *a*	..	..	..	..	+
	35 *c*	..	..	..	..	+
	35 *e*	..	..	..	..	+
	35 *y*	..	..	..	..	+
	36 *a*	+	..	..	+	+

Depth in fathoms.	Haul.	*Collozoum inerme.*	*Collozoum Brandti.*	*Sphærozoum punctatum.*	*Thalassicolla nucleata.*	*Chænicosphæra Murrayana.*
100—0	21 *h*	+	+	..	+	+
	21 *l*	+	..	..	..	+
	22 *a*	..	..	..	+	+
	24 *b*	..	..	..	..	+
	24 *d*	+	..	..	..	+
	24 *e*	+	..	..	..	+
	25 *d*	+	..	..	+	
	30 *g*	+	..	..	..	+
	30 *h*	..	+	..	+	+
	32 *d*	+	..	..	+	+
	32 *i*	+	..	..	..	+
	32 *n*	..	..	..	..	+
	32 *p*	..	..	..	..	+
	33 *d*	..	..	..	..	+
	34 *b*					
	34 *d*	..	..	..	+	+
	35 *b*	..	..	..	..	+
	35 *d*	..	..	..	+	+
	35 *f*	+	..	..	+	+
	35 *x*	..	..	..	..	+
	36 *b*	..	..	..	+	+
	36 *e*	..	..	..	..	+
150—0	36 *f*	..	..	..	..	+
150—50	21 *p*					
150—100	21 *n*					
200—0	21 *a*	..	..	..	..	+
	36 *g*	..	..	..	..	+
200—100	21 *b*					
	21 *o*	F	..	..	..	F
	26 *e*					
	34 *h*	..	..	..	..	F
	35 *m*					
	35 *n*					
	35 *t*					
250—0	36 *h*					
	36 *i*	..	..	..	..	+
	35 *o*					
250—150	35 *p*					
	35 *s*					
300—0	36 *k*	..	..	..	..	+
300—200	21 *c*					
	26 *f*	F				
	35 *l*					
350—0	36 *l*	..	..	..	..	+
400—300	21 *k*					
	32 *l*					
	35 *k*					
500—400	21 *m*					
	35 *h*					
	35 *i*					
750—500	22 *b*					
	30 *k*					
	34 *e*	..	..	..	..	F
	34 *f*	F				
1000—750	23 *a*					
	27 *c*					
	31 *d*					
	32 *f*					
	32 *k*					
1250—1000	24 *a*					
	27 *b*					
	31 *c*					
1500—1250	25 *f*					
	30 *i*					
2000—1500	25 *c*					
	26 *b*					



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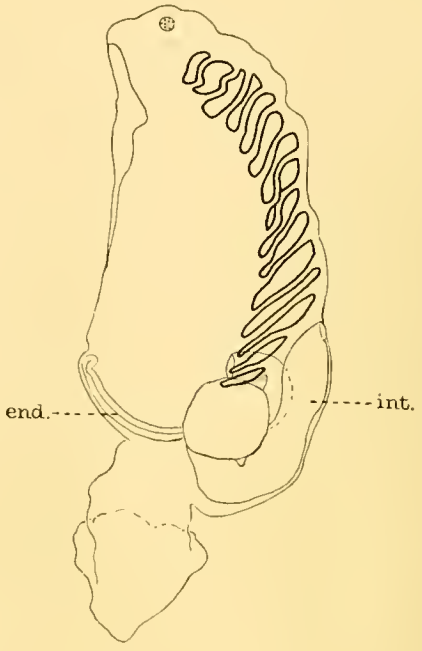

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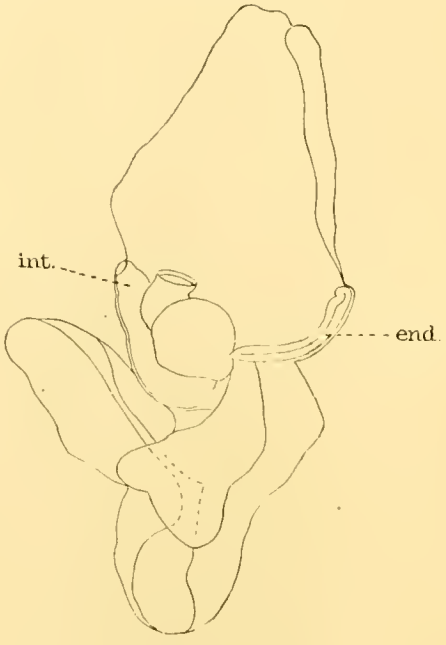

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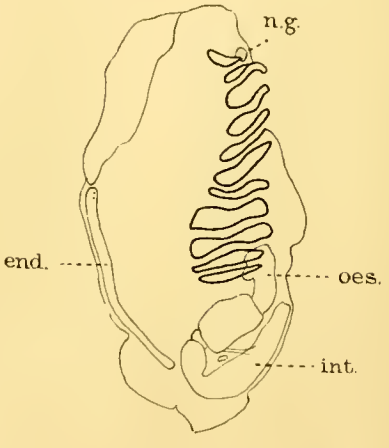


4.

BISCAYAN THALIACEA.

ALL FIGURES ARE MULTIPLIED 37 TIMES.

FIG. 1. BLASTOZOOID A (? = *DOLIOLUM TRITONIS*, HERDMAN).

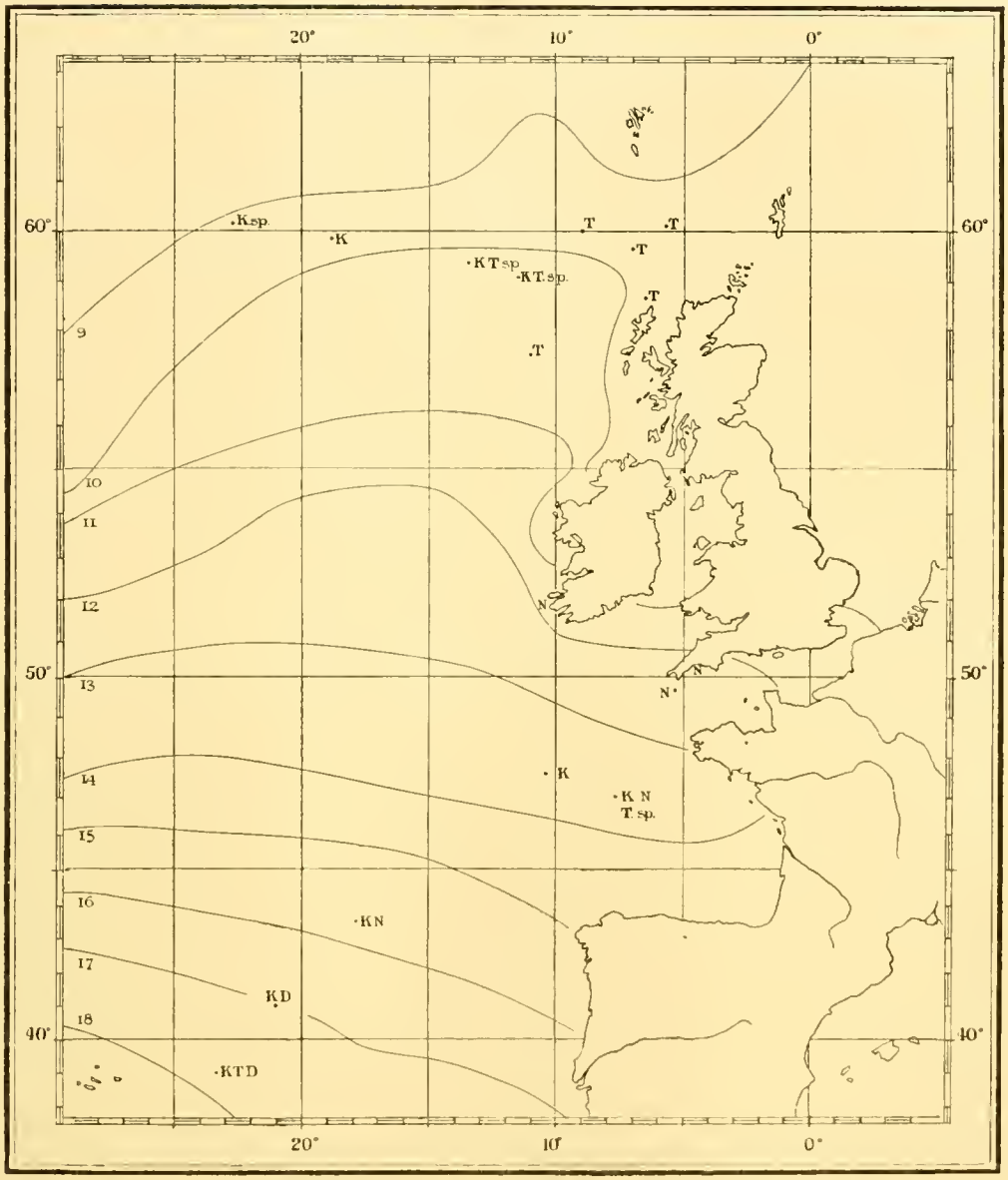
2. TROPHOZOOID A (? = *DOLIOLUM TRITONIS*, HERDMAN), FROM THE LEFT SIDE. THE STALK WAS LONG AND TURNED DOWNWARDS TO A NEARLY TRIANGULAR BASE.

3. TROPHOZOOID A: ANOTHER SPECIMEN, FROM THE RIGHT SIDE, THE GILL-SLITS OMITTED. THE STALK WAS SHORT AND CARRIED TWO LARGE FLAPS, APPARENTLY OF TEST-SUBSTANCE, FOLDED OVER.

4. TROPHOZOOID B, FROM THE LEFT SIDE.

5. INTESTINE OF THE SAME SPECIMEN, FROM THE RIGHT SIDE.

end. endostyle. *n.g.* nerve-ganglion.
int. intestine. *oes.* œsophagus.



DISTRIBUTION OF THALIACEA.

On this Plate have been approximately charted the records of various species of *Doliolum* in the neighbourhood of the British Islands; they include the captures of H.M.S. 'Triton' (1882), H.M.S. 'Research' (1896, 1897, 1900), s.s. 'Holsatia' (1885), s.s. 'National' (German Plankton Expedition, 1889).

As all are epiplankton records, except those of *denticulatum* and *D.* sp., Borgert, the mean annual surface isotherms have also been plotted in degrees Centigrade from Dr. Schott's results.

D. *D. denticulatum.*
K. *D. Krohni.*
N. *D. Nationalis.*
sp. *D.* sp., Borgert.
T. *D. Tritonis.*

BISCAYAN PLANKTON.

Part VII.—MOLLUSCA (*excluding* Cephalopoda).

By Dr. Paul Pelseneer, *Professeur à l'École Normale de Gand.*

(Plates 10–12.)

With a Note on their Distribution.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S., F.Z.S.*

Read 1st June, 1905.

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Pendant le mois de juillet de 1900, sur H.M.S. 'Research,' Dr. G. Herbert Fowler a recueilli le matériel suivant de Mollusques planktoniques, par une distance de 300 kilomètres, environ, des côtes les plus voisines (entre 46° 43′ et 47° 29′ N., d'une part, et 7° 15′ et 8° 18′ W., d'autre part).

Les pêches ont été exécutées de jour et de nuit, entre la surface et 2000 brasses de profondeur ; mais elles n'ont pas rapporté de Mollusques au delà de 1500–1250 brasses.

La collection recueillie comprenait près de 350 spécimens appartenant à une vingtaine d'espèces dont quelques unes seulement étaient représentées par de nombreux individus (et peuvent par conséquent être considérées comme très abondantes dans les couches explorées de la région en question).

Les occurrences des espèces sont enregistrés au table, pp. 156, 157, à la fin du Mémoire.

A. SYSTÉMATIQUE ET MORPHOLOGIE.

I. Larves de Gastropodes.

Il est souvent difficile de déterminer à quel genre (et à fortiori à quelle espèce) appartiennent les larves planktoniques de Gastropodes ; car, bien des fois elles peuvent différer beaucoup de l'adulte, par leurs caractères extérieurs.

Aussi, un grand nombre de genres particuliers ont-ils été fondés autrefois pour ces petites formes pélagiques, dont plusieurs étaient alors considérées comme appartenant aux anciens groupes des "Ptéropodes" ou des "Hétéropodes" : *Cirropteron*, Sars, *Sinusigera* et *Brownia*, d'Orbigny, *Cheletropis* et *MacGillivraya*, Forbes, *Echinospira*, Krohn, *Calcarella*, Souleyet, *Jasonilla*, MacDonald, *Ethella*, Adams, etc.

MacDonald le premier reconnut avec certitude que plusieurs de ces formes se rapportaient à des genres déjà connus à l'état adulte *. Et aujourd'hui il est admis qu'aucun de ces genres n'est valable, bien que les affinités de tous ne soient pas encore connues (il n'y a que dans certains catalogues conchyliologiques qu'on les trouve encore conservés).

Récemment Simroth a décrit un grand nombre de larves pélagiques de Gastropodes, provenant de l'Expédition du 'National' ; mais il n'a pu en identifier qu'une minime partie †.

Cette identification offre toujours des difficultés considérables. C'est le cas aussi pour les larves recueillies par la 'Research,' dont les fluides conservateurs avaient altéré les coquilles calcaires en beaucoup de cas ‡.

Restaient, comme moyen de détermination, la forme générale, le velum et surtout l'opercule et la radula. Toutefois, dans ces petites larves, la radula est d'une petitesse

* MacDonald : "On the probable Metamorphosis of *Pedicularia* and other Forms ; affording Presumptive Evidence that the Pelagic Gasteropoda, so-called, are not adult Forms, but, as it were, the Larvæ of well-known Genera, and perhaps confined to Species living in Deep Water," Trans. Linn. Soc. London, vol. xxii. p. 241 (1859).

† Simroth : 'Die Gastropoden der Planktou-Expedition,' 1895.

‡ [This was due to the unfortunate employment of corrosive sublimate or picric acid in many cases. Formalin alone, which spares even the finest spines of pelagic Foraminifera, did not appear to attack molluscan shells.—G. H. F.]

extrême et se perd facilement dans les manipulations faites pour l'isoler ; en outre, elle n'existe pas chez tous les Gastropodes (par exemple dans les Eulimidæ et Pyramidellidæ). D'autre part, l'opercule larvaire est aussi fort petit, fragile, très mince, transparent et à détails de structure souvent peu perceptibles.

Aussi n'ai-je pu identifier avec une certitude suffisante que quelques unes de ces larves.

i. *Larves à une seule coquille, dextre.*

1. Coralliophila (?), sp. A. (Pl. 10. figs. 1, 2.)

= *Trichotropis fimbriata*, Jeffreys : "On the Mollusca procured during the 'Lightning' and 'Porcupine' Expeditions, 1868–70 [part ix.]," Proc. Zool. Soc. London, 1885, p. 48, pl. 5. fig. 7.

Coquille cornée, à poils longs, disposés sur quelques rangées seulement ; spire assez allongée.—Velum formé de quatre longs lobes, sans pigment. Deux tentacules et deux yeux. Radula absente. Opercule à nucleus assez latéral, mais vers la columelle, spiralé, à spirale sénestre, peu marquée, comme dans l'espèce suivante (fig. 4).

Distribution. La coquille vide de cette larve a été prise aux environs des Féroë, par le 'Porcupine,' jusqu'à 816 fathoms, avec l'espèce suivante, mais moins abondante.

2. Coralliophila (?), sp. B. (Pl. 10. figs. 3, 4.)

= *Trichotropis densistriata*, Jeffreys : "On the Mollusca procured during the 'Lightning' and 'Porcupine' Expeditions, 1868–70 [part ix.]," Proc. Zool. Soc. London, 1885, p. 48, pl. 5. fig. 8.

Coquille cornée, à spire plus courte que l'espèce précédente, ornée de nombreuses rangées spirales de poils peu allongés. Velum divisé en 4 longs lobes sans pigment. Deux tentacules, chacun avec un œil à la base externe ; otocystes avec un otolithe. Pied légèrement échancré en arrière. Radula absente. Opercule très semblable à celui de l'espèce précédente (fig. 4).

Distribution. Trouvé, avec la précédente, à l'état de coquille vide, à 816 fathoms, par le 'Porcupine,' près des Féroë ; également par le 'Talisman,' auprès du Cap Vert, par 1192 fathoms.

Cette espèce ressemble aussi à la larve représentée par Simroth (*loc. cit.* pl. 11. fig. 2), sous le nom de *Nassa* ?, et qui provient de l'Atlantique oriental.

Remarque au sujet de A *et* B.—Aucune de ces deux larves ne possède de radula ; la forme susdite de Simroth est dans le même cas. Ce n'est donc pas un *Trichotropis*, ni d'ailleurs une forme adulte (ce que supposait Jeffreys).

J'opine pour des *Coralliophila* (=*Pseudomurex*, Monterosato, d'après beaucoup de conchyliologistes) ; c'est un des rares genres de Gastropodes Pectinibranchia dépourvus de radula ; il a en même temps un opercule à nucleus latéral, et des otocystes à otolithe.

En outre, certaines espèces de ce genre vivent dans le Golfe de Gascogne : *C. alucoides*, Blainville (=*lamellosa*, Jan), et *C. œdonus*, Watson (tous deux recueillis par le 'Caudan,' à 180 et 400 m.*) ; et *C.* (*Pseudomurex*) *basileus*, Dautzenberg et Fischer, au N. de la Corogne, entre 748 et 1268 m.

* Koehler : "Résultats scientifiques de la Campagne du 'Caudan,'" Ann. Univ. Lyon, 1896, pp. 154, 155.

La larve susindiquée de Simroth a été obtenue dans presque tout l'Atlantique oriental, et la forme B, par le 'Talisman,' près du Cap Vert; or il existe aussi des *Coralliophila* au voisinage des îles Atlantiques tropicales; *C. lactuca*, Dall, aux Açores; *C.* (*Pseudomurex*) *basileus*, Dautzenberg et Fischer, également aux Açores.

3. Columbella haliaëti, Jeffreys. (Pl. 10. figs. 5–9.)

(= *C. costulata*, Cantraine.)

Coquille ventrue, siphonée, à spire modérément allongée, lisse (à peine marquée vers l'endroit le plus saillant des tours, d'une double strie spirale) (fig. 5).

Velum quadrilobé (figs. 6, 7), dont les lobes sont fort larges. Deux yeux. Radula rachiglosse, à dent centrale encore peu développée (ne résistant pas à l'action de la potasse caustique); dents latérales tout-à-fait caractéristiques et propres aux *Columbella* (ou *Pyrene*)* (fig. 9).

Opercule spiralé, paucispiré, à nucleus tout-à-fait latéral (fig. 8), ressemblant quelque peu à celui figuré par Simroth, sous le nom de "*Triton*?" †, mais vu par sa face *intérieure* certainement.

Dans la région S.W. de l'Europe, il y a une espèce *littorale* de *Columbella*: *C. rustica*, Linné, du Portugal ‡. Mais la radula diffère notablement de celle de notre larve; et d'ailleurs, les larves d'espèces littorales ne se rencontrent pas à une telle distance (300 kilomètres) des côtes.

Au contraire *C.* (*Pyrene*) *haliaëti* est abondant dans la profondeur de l'Atlantique Nord: Shetlands, Norvège, Finmark, Groënland, et même Amérique du N. (Massachusetts: Gulf of Maine, Bay of Chesapeake §); et cette espèce est enfin fréquente dans le Golfe de Gascogne: 1107 et 1576 m. (Expédition du 'Travailleur').

Il est donc très vraisemblable que c'est à cette forme que se rapporte notre larve, malgré une minime différence dans la radula, telle qu'elle est figurée pour l'adulte par Sars ‖.

L'absolue certitude au sujet du genre, permet de faire connaître la transformation subie par l'opercule. Celui-ci—écailleux, triangulaire et à nucleus latéral, chez l'adulte—est nettement spiralé chez la larve (fig. 8). Un fait analogue s'observe dans *Nassa* (fig. 13) et ? *Coralliophila* (fig. 4); ce qui rend probable que tous les opercules sont spiralés à l'origine. La partie la plus antérieure, dépassant la spire, est une formation plus récente, résultant de la modification de forme de l'ouverture coquillière; une semblable addition s'observe encore dans d'autres formes, où la spire operculaire reste visible chez l'adulte (*Sigaretus*) ¶.

* *Vide* Troschel: 'Das Gebiss der Schnecken,' vol. ii. pl. 9.—Fischer: 'Manuel de Conchyliologie,' p. 637.—Cooke: 'Molluscs,' p. 123.

† Simroth: 'Die Gastropoden der Plankton-Expedition,' 1895, pl. 5. fig. 3.

‡ Kobelt: 'Prodromus Faunæ Molluscorum Testaceorum maria Europæa inhabitantium,' 1886, p. 56.

§ Verrill: Trans. Connecticut Acad. vol. v. pl. 43. fig. 7.

‖ Sars: 'Mollusca Regionis Arcticæ Norvegiæ,' 1878, pl. 10. fig. 2.

¶ Souleyet: 'Zoologie du Voyage de la 'Bonite,' Mollusques, pl. 35. figs. 20, 21.

4. Natica sp. (Pl. 10. figs. 12–15.)

Coquille globuleuse, lisse et sans coloration, à spire très peu saillante (fig. 12).

Velum tetralobé, portant une tache pigmentaire à l'extrémité libre de chaque lobe (fig. 14), comme une larve de *Nassa* des Féroë et certains "*Sinusigera*." Radula tænioglosse (2.1.I.1.2), naticoïde (fig. 13), avec une première dent marginale pourvue de deux denticules caractéristiques du "sous-genre" *Lunatia*. Mandibules formées d'écailles imbriquées, à pointes saillantes.

Opercule corné, semi-lunaire, paucispiré (fig. 15).

Le spécimen de la station 21 *h* différait des autres seulement par son velum sans taches pigmentées; pour le reste, il avait la même radula, les mêmes mandibules et le même opercule. Toutefois, cette différence ne me paraît pas dûe à la dissolution du pigment dans le liquide conservateur; car, la larve 21 *h* était dans le formol, de même que 31 *b* et 33 *g*, et 24 *b* dans l'alcool; et les trois derniers avaient taches pigmentaires également bien conservées. Peut-être sont ce des larves de deux espèces très voisines.

En tout cas, ces quatre larves appartiennent à des *Natica* à opercule corné (et non calcaire) du groupe *Naticina* ou *Lunatia*, avec une première dent marginale portant deux denticules terminaux subégaux (le plus postérieur étant le plus petit). Troschel avait déjà reconnu l'existence d'un groupe naturel ainsi caractérisé, comprenant notamment: *N. helicoides*, *N. lactea*, *N. grœnlandica* et *N. pallida* (ces deux dernières peut-être identiques *.

Ce groupe renferme diverses formes abyssales, *N. grœnlandica*, *N. nana*, etc. La campagne du 'Caudan' a signalé *N. nana*, Lovén, dans le Golfe de Gascogne; mais la radula en est un peu différente †. Le même campagne a rapporté aussi, de 1710 m., des "espèces nouvelles" voisines de *nana* et de *grœnlandica*. Enfin, l'Expédition du 'Travailleur' a trouvé assez abondamment dans le Golfe de Gascogne, *N. subplicata*, Jeffreys: c'est peut-être à cette espèce qu'il faudrait rapporter notre larve; mais la radula de *N. subplicata* n'est pas connue.

ii. *Larves à une seule coquille, sénestre ou hétérostrophe.*

5. Solarium? sp. (Pl. 10. figs. 10, 11.)

Coquille pseudosénestre, sans spire saillante, ressemblant aux formes dites "*Agadina*," et n'appartenant pas à un Thécosome Limacinidæ, car la larve qui s'y trouve possède un velum tétralobé et deux gros yeux. L'animal est dextre, avec le cœur à gauche: c'est donc bien une larve de Gastropode à coquille dont le sommet est hétérostrophe (ou "anastrophe" d'après Dautzenberg et Fischer, qui réservent le terme hétérostrophie au changement de direction de l'axe et non au changement de sens de l'enroulement).

Une autre preuve s'en trouve encore dans l'opercule (fig. 11); celui-ci est spiralé, à enroulement sénestre et à spire dont le nucléus est dirigé vers le sommet de la coquille larvaire (fig. 10); or, on sait que ce nucléus est toujours dirigé vers l'ombilic de

* Troschel: 'Das Gebiss der Schnecken,' vol. i. p. 74.

† Sars: 'Mollusca Regionis Arcticæ Norvegiæ,' pl. 5. fig. 14.

l'adulte. Cet opercule est orbiculaire, concave extérieurement et à petit nucléus saillant intérieurement.

Je rapporte cette larve au genre *Solarium*. On sait que chez celui-ci, le sommet est hétérostrophe *. Une figure de Hedley en donne une démonstration bien nette †. La radula m'a échappé ; ce que j'attribue à la grande longueur de la trompe, qui peut être plus ou moins invaginée et entraîner la radula jusqu'auprès de l'estomac ‡ ; de sorte qu'on ne la trouve pas à la place habituelle.

Il existe d'ailleurs dans le Golfe de Gascogne plusieurs *Solarium* : notamment *S. architæ*, Costa, et *S. fallaciosum*, Tiberi (=*S. siculum*, Cantraine), à 180 et 400 m. (Campagne du 'Caudan') ; et *S. pseudoperspectivum*, Brocchi (Expédition du 'Travailleur').

iii. *Larves à deux coquilles.*

6. Lamellaria, sp. A. (Pl. 10. figs. 20, 21 ; Pl. 11. figs. 25, 26, 27.)

Coquille externe "cartilagineuse," aplatie latéralement, à tours tous visibles, pourvue de deux carènes centrales et de deux carènes latérales peu saillantes, à dents petites et plutôt courtes. Ouverture caractérisée par un rostre ventral, médian, non appliqué sur le tour précédent (fig. 21).

Coquille interne ou définitive (figs. 26, 27), auriforme, à spire courte, formée de $2\frac{1}{2}$ tours, peu saillante.

Pied sans opercule (celui-ci étant peut-être déjà caduc, à l'âge de la larve recueillie). Velum à quatre lobes saillants (fig. 26). Radula ayant pour formule 1 . 1 . 1, à dent centrale en chevron, légèrement asymétrique, la branche droite (à gauche sur la figure) étant la plus grande ; c'est la dentition tout-à-fait caractéristique de *Lamellaria* et spéciale à ce genre.

Cette forme me paraît ressembler seulement à la coquille figurée par Lo Bianco §, sous le nom de *Echinospira compressa*, bien que la larve, sa radula et sa coquille définitive n'en soient pas connues.

7. Lamellariide. (Pl. 10. figs. 16–19.)

Coquille externe "cartilagineuse," aplatie latéralement, à dernier tour cachant les précédents, à carènes presque nulles et sans ligues d'épines ; présentant une légère asymétrie, le rostre dorsal de l'ouverture étant dirigé vers le côté "ombilical" ou gauche.—Coquille définitive excessivement mince, formée de $2\frac{1}{2}$ tours, croissant très rapidement, à ouverture orbiculaire très grande, et à spire très peu saillante.

* Jousseaume : Bull. Soc. Zool. France, vii. 1882, p. xxx.—Watson : "Report on the Gastropoda," Zool. Chall. 1886, p. 137.—Dautzenberg et Fischer : Mém. Soc. Zool. France, ix. 1896, p. 57.

† Hedley : "Scientific Results of the Trawling Expedition of H.M.C.S. 'Thetis,' Mollusca, part ii." Memoirs of Australian Museum, iv. 1903, p. 349, fig. 73.

‡ Troschel : 'Das Gebiss der Schnecken,' vol. ii. pl. 15. fig. 6.

§ Lo Bianco : "La pesche abissali eseguite da F. A. Krupp col yacht 'Puritan,' nelle adiacenze di Capri ed in altre località del Mediterranea," Mitteilungen zool. Stat. Neapel, xvi. 1903, p. 179, pl. 8. fig. 23.

Velum à quatre lobes saillants (fig. 19) ; tentacule droit, seul bien développé (comme dans la larve nageuse de certaines autres Gastropodes). La radula n'a pas été trouvée et a peut-être échappé.

Opercule vitré, lisse et mince, spiralé, à plusieurs tours (fig. 18).

8. Lamellaria, sp. B. (Pl. 10. figs. 22, 23 ; Pl. 11. figs. 24, 28, 29.)

Coquille externe "cartilagineuse," épaisse, à ouverture étroite dans le sens dorso-ventral, à carènes écartées l'une de l'autre et portant des épines robustes et saillantes. Dernier tour cachant complètement les précédents. Ouverture à rostre dorsal très saillant et à bord ventral appliqué sur la coquille.—Coquille définitive capuliforme, non enroulée.

Velum à six lobes (fig. 24) allongés. Deux tentacules très longs et égaux ; branchie présentant déjà trois filaments. Radula ayant pour formule 1. I. 1, et constituée des dents caractéristiques de *Lamellaria* (fig. 29). Mandibules paires et séparées (fig. 28), épineuses et peu élevées, imparfaitement symétriques, ressemblant à celles observées par Krohn sur la larve *Echinospira diaphana* * ; elles ressemblent aussi vaguement à celles de *Marsenina* †, et diffèrent de celles de *Lamellaria* adulte, où comme on sait, la mandibule est impaire (résultant de deux pièces soudées sur la ligne médiane).—Pas d'opercule.

Remarques sur les trois formes précédentes.

1°.—La deuxième larve ressemble à celle décrite par MacDonald ‡, ce qui me fait supposer qu'elle avait une radula de la formule 2 . 1 . I . 1 . 2, comme celle-là ; ce caractère, joint à la croissance rapide des tours de la coquille définitive et à son ouverture orbiculaire, me portent à voir dans cette larve l'état jeune d'un *Velutina*. On sait qu'une espèce de ce genre : *V.* (*Velutella*) *flexilis*, Montagu, vit dans les zones profondes de l'Atlantique Nord.

2°.—Les deux autres larves appartiennent sûrement à des *Lamellaria* ; la dernière ressemble à celle que Krohn a décrite sous le nom de *Echinospira diaphana* (mêmes coquille, radula et mandibules, même nombre de lobes au velum), et que cet auteur considère comme la larve de *Lamellaria perspicua*, Linné.

La seule autre espèce de *Lamellaria* connue à l'état adulte dans l'Atlantique N. est *L. tenuis*, Jeffreys (recueillie par le 'Porcupine,' par 816 brasses) ; peut-être la larve A s'y rapporte-t-elle ?

II. Hétéropode.

9. Carinaria sp. (Pl. 11. figs. 30–40.)

1°.—33 prises ont donné en abondance des larves véligères de Gastropode, à coquille spiralée, aplatie, "valvatiforme," représentée figs. 30, 34, 35. Ces larves, si communes, ne manquent que aux stations nos. 22, 27 et 29, c'est-à-dire dans *les grandes profondeurs* ;

* Krohn, "Nachtrag zu dem Aufsatze über dio *Echinospira diaphana*," Arch. f. Naturgesch. 1858.—Troschel : 'Das Gebiss der Schnecken,' vol. i. pl. 16. fig. 2.

† Bergh : "Report on the Marseniidæ," Zool. 'Challenger' Exped. pt. xl. pl. i. fig. 14.

‡ MacDonald : "On the probable Metamorphosis of *Pedicularia*," Trans. Linn. Soc. Lond. xxii. pl. 42. s. 12, 13.

on peut donc dire que ces organismes pullulent dans les eaux superficielles; ils n'ont jamais été rencontré au-dessous de 200 brasses, ils n'ont jamais été pris dans des filets fermés avant d'atteindre à la surface, et ils presque tous été capturés entre 50 et 0 brasses, 4 fois entre 100 et 0 brasses, 1 seule fois (1 exemplaire) entre 350 et 0 brasses.

L'examen a montré que ces larves appartiennent à un Hétéropode, par les caractères suivants:—

(1°) deux gros yeux à axes allongés, à cristallin éloigné de la rétine (fig. 44);

(2°) opercule vitré, spiralé, paucispiré, sénestre (figs. 34, 41) (comme dans tous les Hétéropodes adultes quand ils sont operculés; les opercules représentés erronément dextres *, sont vus par la face interne);

(3°) velum à 6 lobes (fig. 38): caractère connu seulement chez les Atlantidæ, Carinariidæ †, quelques Strombidæ ‡ et *Lamellaria* (fig. 24);

(4°) nageoire pédieuse aplatie bilatéralement, "mésopodium," avec un rudiment saillant de ventouse à son bord ventral (fig. 31, *t.o.*);

(5°) et s'il restait le moindre doute, la radula, à formule 3.I.3, identique à celle des Hétéropodes, caractéristique par la forme de la dent centrale et de la première latérale (fig. 39).

Cette larve est peut-être la même que celle renseignée par Simroth § dans la région N.E. de l'Atlantique, vers 25° N. et 31° W.

2°.—Quelques prises ont donné aussi un jeune Hétéropode immature, testacé, mais à corps non rétractile dans la coquille (fig. 36), laquelle est pareille à celle de la larve ci-dessus. Voici, du reste, comment l'on peut décrire ce jeune Hétéropode:

Tête énorme, à masse buccale très forte; deux tentacules (dont le droit est parfois absent: caractère sexuel ?); masse viscérale enroulée en spirale et tout entière contenue dans une coquille entièrement spiralée aussi. Manteau faisant antérieurement saillie sur la ligne médiane, par un lobe (*pa.*) protégeant la branchie (laquelle comprend 6 ou 7 filaments). Nageoire à ventouse postérieure. Métapodium allongé, portant à son extrémité libre une nageoire ventrale, horizontale, bifurquée, à pigment brun sombre sur sa face inférieure (fig. 33).—Dimensions: 8 millimètres au maximum.

3°.—L'identité de cet Hétéropode immature avec la larve ci-dessus, ressort bien des observations suivantes:—

(*a*) identité de la coquille (figs. 32, 34);

(*b*) identité de la radula;

(*c*) identité de la nageoire métapodiale (*fi.'*) avec celle que présentent les individus âgés de la larve (fig. 31), sur le lobe operculigère (=métapodium) mais qui est alors asymétrique (le lobe droit étant le plus grand);

* Simroth: 'Bronn's Thierreich,' Bd. iii. Gastropoda, pl. 19. 2 *b*.—Vayssière: "Résultats des Campagnes scientifiques accomplies sur son Yacht par Albert 1er, Prince souverain de Monaco," fascicule xxvi., Mollusques Hétéropodes, 1904, pl. 6. fig. 87.

† Gegenbaur: 'Untersuchungen über Pterepoden und Heteropoden,' 1855, pl. 8. figs. 1, 2.

‡ MacDonald: "Further Observations on the Anatomy of *Macgillivraya*, *Cheletropis*, and allied Genera of Pelagic Gastropoda," Phil. Trans. Roy. Soc. London, 1865, pl. 16. fig. 18.

§ Simroth: 'Die Gastropoden der Plankton-Expedition,' p. 135, pl. 13. figs. 13, 17.

(*d*) identité des stations : le jeune hétéropode et la larve ont été recueillis quatre fois ensemble, à la même profondeur (toujours pendant la nuit).

Les chiffres de la table (pp. 156, 157) comprennent les spécimens de ce jeune immature, provenants des prises :—

30 *l.*	50 to 0 fathoms.	1 specimen.
31 *b.*	50 to 0 fathoms.	3 specimens.
32 *a.*	50 to 0 fathoms.	1 specimen.
34 *a.*	25 to 0 fathoms.	1 specimen.

La comparaison de la larve avec le jeune immature permet de résoudre, d'une façon certaine, plusieurs questions laissées douteuses par Krohn. Il présumait * que le lobe operculigère de la larve devient le métapodium de l'adulte : ceci est confirmé par la persistance temporaire, sur le métapodium, de la membrane pigmentée observée sur le lobe operculigère des larves âgées (fig. 31, *fi.'*).—D'autre part Krohn ignorait si la ventouse apparaît avant ou après la réduction du velum : nos larves montrent bien que le rudiment saillant de la ventouse (fig. 31 et 36, *su.*) apparaît *avant* la réduction du velum.

4°.—Enfin, l'identité de ce jeune Hétéropode immature lui-même, avec le genre *Carinaria* présente une certitude presque absolue, par suite des faits suivants :—

(*a*) nucléus viscéral entièrement contenu dans la coquille ;

(*b*) coquille du jeune Hétéropode identique au "nucléus" spiralé de la coquille des *Carinaria* adulte (nucléus qui a été reconnu pour la 1ère fois par d'Orbigny †, et depuis lors par divers auteurs ‡) ;

(*c*) forme du mufle et des tentacules ;

(*d*) les lames branchiales saillantes en petit nombre : chez le jeune (6 ou 7), comme dans les *Carinaria* adultes (7 à 12) § ;

(*e*) radula semblable ;

(*f*) nageoire métapodiale pigmentée, observée aussi par Lo Bianco (renseignement inédit) sur les très jeunes *Carinaria*.

5°.—Les *Carinaria* de l'Atlantique sont demeurés longtemps mal connus ; et autrefois, un petit nombre d'espèces, seulement, étaient indiquées de cet Océan :—

(*a*) *C. fragilis*, Bory de St. Vincent, des environs du Cap de Bonne Espérance, dont la coquille avait été détruite ‖ ;

(*b*) *C. atlantica*, Adams, sans indication précise de localité ¶ ;

(*c*) *C. Gaudichaudi*, MacDonald, probablement des Antilles ** ;

* Krohn : 'Beiträge zur Entwickelungsgeschichte der Pteropoden und Heteropoden,' 1860, p. 36.

† D'Orbigny : 'Voyage dans l'Amérique méridionale,' vol. v. (1847) p. 161, pl. 11. figs. 14, 15 (*C. punctata*).

‡ MacDonald : "On the Anatomy and Classification of the Heteropoda," Trans. Royal Soc. Edinburgh, xxiii. 1862, pl. 2. figs. 4, 4'.—Vayssière : 'Campagnes scientifiques,' etc. pl. 4. fig. 54.—Smith : "Report on the Heteropoda," Zool. 'Challenger' Exped. pt. lxxvii. p. 31.

§ Costa : Ann. d. Sci. nat. sér. 1, t. xvi. pl. 1.—Milne-Edwards : *ibid.* sér. 2, t. xviii. pl. 11. fig. 1.

‖ Bory de St. Vincent : 'Voyage dans les 4 principales îles d'Afrique,' vol. i. p. 141, pl. 6. fig. 4.

¶ Adams and Reeve : 'Zoology of the Voyage of the "Samarang" in the Eastern Seas.'—Gray : 'Figures of Molluscous Animals,' vol. iv. p. 100, pl. 239. fig. 2.

** MacDonald : "On the Anatomy and Classification of the Heteropoda," *loc. cit.* p. 18, pl. 2. fig. 4.

Mais aucune forme n'avait été mentionée au voisinage de l'Europe, jusqu'en 1881, où ce genre fut dragué au N. de l'Espagne, par l'Expédition du 'Travailleur' *. Cependant, il y est relativement abondant, puisque l'Expédition du 'Challenger' en rencontra aussi au large du Cap St. Vincent et un peu plus au Sud †, ainsi que par 35° N. et 23° W. *Carinaria* à coquille détruite ‡.

Puis, récemment, Vayssière en a décrit trois formes provenant de pêches de la 'Princesse Alice' dans l'Atlantique Nord § :—

(*a*) *C. Lamarcki*, var. *oceanica* (peut-être la même que la dernière espèce citée du 'Challenger') ;
(*b*) *C. Grimaldii* (individu jeune) ;
(*c*) *C. pseudorugosa* (individu incomplet, sans coquille, ni nucléus).

Mais tous trois, ainsi que les spécimens du 'Challenger' et du 'Travailleur' proviennent d'une région au S.W. des Stations de la 'Research' et comprise entre 39° et 45° N., et 14° et 37° W., et l'on sait que les vents régnants de cette partie de l'Atlantique soufflent de l'W.

Les jeunes spécimens immatures ressemblent un peu à *G. Grimaldii*, Vayssière ; mais celui-ci n'est peut-être que la forme jeune d'une espèce connue. Nous ne pouvons donc que rapporter larve et jeune immature simplement au genre *Carinaria*, sans pouvoir indiquer à quelle espèce elle appartient.

III. Thécosomes.

10. Peraclis triacantha (Fischer) ‖. (Pl. 11. figs. 41, 42, 44 ; Pl. 12. figs. 43, 47.)

Cette espèce a d'abord été décrite, mais non figurée, par Fischer, d'après des coquilles vides, sous le nom de *Embolus triacanthus*. Je l'ai figurée depuis, également d'après des coquilles vides, sous le nom de *Limacina triacantha*. Depuis, Tesch avait déjà pressenti que le vrai genre de cette forme est *Peraclis* ¶. L'expédition de la 'Research' en a, la première, rapporté un animal complet, et a donné la démonstration expérimentale de l'hypothèse de Tesch : car l'examen de l'opercule seul montre déjà que la forme en question est bien un *Peraclis* (fig. 42) ; en effet, cet opercule est orbiculaire, multispiralé, sénestre et à nucléus subcentral (au contraire, les opercules de *Limacina* sont allongés, paucispirés et à nucléus latéral, placé vers la gauche de l'animal, c'est-à-dire vers la fausse spire).

Distribution. Cette espèce est répandue dans tout le N. Atlantique.

11. Peraclis brevispira, sp. n. (Pl. 12. figs. 45, 46, 48, 49, 51.)

Coquille lisse, formée de $2\frac{1}{2}$ tours assez large, à spire très peu saillante ; suture ornée

* Jeffreys : Ann. & Mag. Nat. Hist. ser. 5, vol. vi. p. 318.

† 'Summary of the Results,' pp. 117, 119.

‡ Smith, E. A. : "Report on the Heteropoda," Zool. 'Challenger' Exped. pt. lxxvii. p. 37.

§ Vayssière : "Résultats des Campagnes scientifiques, etc.—Mollusques Hétéropodes," pp. 17, 18, 20.

‖ Fischer : "Diagnoses d'espèces nouvelles de Mollusques recueillis dans le cours de l'Expédition scientifique de l'Aviso le 'Travailleur' (1880, 1881)," Journal de Conchyliologie, t. xxx. 1882, p. 49.—Pelseneer : "Report on the Pteropoda," Zool. 'Challenger' Exped. pt. lxv. 1887, p. 20, pl. 1. figs. 1, 2.

¶ Tesch : "The Thecosomata and Gymnosomata of the 'Siboga' Expedition," Siboga-Expeditie, Monogr. lii. p. 19.

de petites lamelles rayonnantes, surtout visibles au dernier tour (fig. 51); bec columellaire pointu, et arqué, comme dans les autres espèces; ouverture large. Opercule subcirculaire, multispiré, à spirale sénestre, à nucléus subcentral (fig. 49, *op.*); cet opercule présente, plus nettement encore que l'espèce précédente, une zone obliquement striée, dans la portion la plus centrale des tours de spire.

Outre les prises "comparables" de la table (pp. 156, 157), cette espèce était pêchée en 27 *a* (1250–0 fathoms).

Organisation et Relations phylogénétiques du Genre Peraclis.

L'organisation du genre *Peraclis* était déjà quelque peu connue, mais n'avait pu être étudiée que sur des espèces de très petite taille †. Les dimensions beaucoup plus considérables de *P. triacantha*, recueilli par l'Expédition de H.M.S. 'Research,' permettent de compléter notablement les observations faites précédemment.

La tête est en forme de trompe saillante (fig. 41, *h.*), comme dans les autres *Peraclis* et les Cymbuliidæ. Les deux tentacules sont symétriques (fig. 41, *t.*); l'orifice pénial (*pe.*) est à droite et un peu en arrière du tentacule droit. Les nageoires (*fi.*) ont leur bord antérieur continu, sans le petit lobe tentaculiforme des grands *Limacina* (*L. helicina* et *L. antarctica*).

Le bord du manteau porte, au côté droit, le même appendice saillant et pointu, ou "balancier," que les autres Limacinidæ (*ba.*). La glande palléale (bouclier) est asymétrique, en ce sens qu'elle est plus développée au côté droit, et obliquement orientée (*pa.g.*).

L'ouverture de la cavité palléale n'est pas antérieure ni symétrique :—le bord dorsal du manteau présente une échancrure vers la ligne médiane (fig. 41); à partir de cette ligne médiane (fig. 41*), il est soudé au corps, sur la moitié gauche, de sorte que l'ouverture de la chambre palléale est située sur la *moitié droite* du corps.

Hors de cette ouverture palléale, fait saillie l'extrémité libre d'une branchie cténidiale de structure "plissée," dont la pointe est dirigée en avant, vers la droite (*g.*). Le rein est situé vers la gauche; et le cœur est à gauche du rein, et disposé à la manière "prosobranche" (comme tous les Limacinidæ, *Peraclis* a donc une organisation dextre, dans une coquille en apparence sénestre).

Le tube digestif offre les mêmes caractères que celui de *Limacina* (notamment les quatre grandes plaques masticatrices du gésier); mais la *radula* (fig. 44), comprenant 11 rangées, offre une dent centrale beaucoup plus large que celle de ce dernier genre ‡, et la pointe médiane de cette dent est beaucoup plus courte. Les dents latérales sont aussi plus larges que dans *Limacina* (figs. 45, *l.*, 47, 48). Enfin les mandibules, qui sont

† Pelseneer: "Report on the Pteropoda, part iii.," Zool. 'Challenger' Exped. pt. lxvi. pp. 11, 12 (1888).—Tesch: "The Thecosomata and Gymnosomata of the 'Siboga' Expedition," Siboga-Expeditie, Monogr. lii. pp. 17, 18 (1904).

‡ Voyez, par exemple, Lovén: "Malacozoologi," Öfv. K. Vet.-Akad. Förhandl. 1847, pl. 3.—Sars: 'Mollusca Regionis Arcticæ Norvegiæ,' 1878, pl. 16. figs. 17, 18, 19.—Pelseneer: "Mollusques," Expédition antarctique belge, pl. 6. fig. 74.

latérales, diffèrent aussi de celles des *Limacina* : elles sont formées de 5 rangées parallèles de plaques rectangulaires, à bord rectiligne, avec chacune 3 dents en général, chez *P. triacantha* (fig. 43) et 7 ou 8 dents chez *P. brevispira* (fig. 45); au contraire, chez *Limacina*, ces plaques sont semicirculaires, à bord libre curviligne et imbriquées alternativement comme les tuiles d'un toit *.

Quant au système nerveux central, il présente les mêmes dispositions générales qu'il montre chez les Thécosomes, avec cette particularité que, de même que les autres *Peraclis* et les Cymbuliidæ, il possède une chaîne de trois ganglions viscéraux.

Si l'on considère cette description en elle-même, on la trouvera naturellement insignifiante. Elle acquiert, au contraire, une certaine importance si on la compare aux dispositions connues de l'organisation des autres Thécosomes et des Gastropodes.

Il est généralement admis que les Limacinidæ sont les plus primitifs des " Ptéropodes " Thécosomes, les Cavoliniidæ et les Cymbuliidæ provenant de ces Limacinidæ par détorsion (ce que j'ai indiqué en 1892 †, c'est-à-dire bien avant que personne ait parlé de détorsion chez les Gastropodes Enthyneura).

Mais, parmi les Limacinidæ, on n'avait pu déterminer en se basant sur un grand nombre de caractères la forme générique actuelle la plus archaïque dans son organisation. L'étude anatomique de *Peraclis triacantha* permet de le faire maintenant, avec assurance.

En effet :

1°.—Tous les Thécosomes, par l'acquisition d'une symétrie extérieure (si commune dans les Mollusques pélagiques) possèdent une ouverture palléale symétrique ;—seul, *Peraclis* montre encore une ouverture palléale latérale (à droite), comme dans les Tectibranches Bulléens ;

2°.—Tous les Thécosomes sont dépourvus de cténidium (quelques Cavoliniidæ ont, au fond de la courte palléale, une branchie en fer à cheval, dont la nature cténidiale est demeurée jusqu'ici obscure) ;—seul, le genre *Peraclis* montre un cténidium normal, du type plissé, à extrémité libre saillante antérieurement, comme dans les Bulléens archaïques ou " Prosobranches," tels que *Actæon* (comparer les figs. 50 et 52).

Ces deux caractères essentiels ajoutés à celui de la dent centrale de la radula et à la multiplicité des ganglions viscéraux, montrent que le genre *Peraclis* est le plus archaïque des Thécosomes actuels ‡ et viennent ainsi confirmer la position attribuée dès 1888 § à ce genre, tout à la base de l'arbre phylogénétique des " Ptéropodes " Thécosomes.

L'existence, parmi les Bulléens, de formes actuelles (telles que *Acera*), à larges parapodies natatoires, à tête allongée, à appendice palléal correspondant au balancier des Limacinidæ, et à spire courte, permet d'inférer que d'autres formes plus anciennes encore operculées et à spire nulle (comme il en existe à la fin de l'époque secondaire) ont pu faire saillir une " fausse spire " au côté ombilical et constituer ainsi les Limacinidæ ultra-

* Sars : 'Mollusca Regionis Arcticæ Norvegiæ,' pl. 11. fig. 3, *d*.

† Pelseneer : " A propos de l'asymétrie des Mollusques univalves," Journ. de Conchyl. 1892, p. 232.

‡ Pelseneer : " Sur la forme archaïque des 'Ptéropodes' Thécosomes," Comptes rendus Acad. Sci. Paris, t. cxxxix. 1904, pp. 546–548.

§ Pelseneer : " Report on the Pteropoda," Zool. 'Challenger' Exped. pt. lxvi. p. 35.

dextres, c'est-à-dire à organisation dextre dans une coquille à enroulement en apparence sénestre.

12. Limacina retroversa, Fleming.

13. Clio pyramidata, Brown.

14. Clio cuspidata, Bosc.

15. Cavolinia inflexa, Lesueur.

IV. Gymnosomes.

16. Fowlerina Zetesios, gen. et sp. nn. (Pl. 12. figs. 53–60.)

Cinq adultes plus ou moins grands (la taille maximum est 8·5 millimètres) et deux larves, proviennent de 6 stations.

Ces individus présentaient des aspects très divers, dûs à des états différents de contraction et aux agents conservateurs variés (acide osmique, formol, alcool) employés. De sorte que, à première vue, on pouvait supposer qu'il y avait-là plusieurs formes distinctes, et que leur identité à tous a été seulement reconnue par l'examen de la radula.

En effet, l'un avait le corps et le pied gonflé (fig. 53), tandis que sur les autres l'extrémité du corps et la partie postérieure du pied, gardaient leur forme pointue et offraient des nageoires très contractées (figs. 54, 55); enfin, dans les différents spécimens, la trompe était à des états variés d'évagination ou d'invagination.

J'ai donc représenté plusieurs de ces individus, afin de faire voir les caractères essentiels montrés sur des spécimens divers.

Du point de vue de la *forme générale*, le corps est terminé en pointe postérieurement (figs. 53, 54), les viscères ne s'étendant pas jusque-là. La peau est pigmentée; il n'y a pas de branchie, ni postérieure ni latérale.

La *tête* est courte, portant deux paires de tentacules (fig. 59).—Le *pied* présente un lobe postérieur pointu postérieurement et assez allongé, sauf dans le plus grand spécimen (fig. 52), où il est très contracté par l'enflure générale de la partie antérieure du pied. L'anus et l'osphradium sont situés assez bien en arrière du pied (fig. 52, *a.* et *os.*). Les nageoires sont amples.

La cavité buccale porte une seule paire d'appendices (ou céphalocônes) latéro-ventraux, ayant la même structure que ceux de *Clione*, c'est-à-dire portant de nombreuses petites papilles serrées (fig. 59, *cc.*). La trompe est à peu près aussi large que longue. La *mâchoire* médiane (figs. 54 et 60), en forme de croissant, à concavité antérieure, est formée d'environ 18 dents pointues, serrées les unes contre les autres. Les *sacs à crochets*, peu profonds, renferment une quinzaine de crochets, plutôt courts (fig. 58). La *radula* présente 17 à 20 rangs de 4.1.4, 5.1.5 ou 6.1.6, suivant l'âge (dans d'autres Gymnosomes [*Clione*], divers Aplysiens, et certains Pulmonés terrestres, le nombre des dents d'une rangée transversale augmente aussi avec l'âge). La dent médiane est arquée, large,

sans aucun denticule central, et pourvu d'une demi-douzaine de petits denticules de chaque côté (fig. 57); les dents latérales sont coudées et terminées en pointe aiguë.

Cette forme se distingue de tous les genres connus; je la nomme *Fowlerina Zetesios* (en l'honneur du distingué zoologiste qui dirigea les campagnes de la 'Research,' et de ce dernier navire).

Fowlerina s'écarte:

(*a*) des Pneumonodermatidæ (*Pneumonoderma*, Cuvier; *Dexiobranchæa*, Boas; *Spongiobranchæa*, d'Orbigny; *Schizobrachium*, Meisenheimer), par l'absence de branchie et de ventouses;

(*b*) des Clionopsidæ, par la brièveté de la trompe, la présence d'un lobe postérieur du pied, l'absence de branchie;

(*c*) des Notobranchæidæ, par la présence d'une dent radulaire médiane et d'une mandibule, par l'absence de branchie;

(*d*) des Thliptodontidæ, par la présence d'une mandibule * et de céphalocônes;

(*e*) des Halopsychidæ, par la présence de pigment dans la peau, de céphalocônes et de sacs à crochets.

Au contraire, le nouveau genre se rapproche des Clionidæ: par le corps pointu, sans branchies et sans viscères jusqu'au bout; par le pied à lobe postérieur présent et pointu, par la présence de céphalocônes et de dents centrales à la radula.

Cette famille Clionidæ ne comprend que deux genres bien établis: *Clione*, Pallas, et *Paraclione*, Tesch. Tous deux sont dépourvus de mandibule † et tous deux possèdent une dent radulaire centrale pourvue d'un denticule médian saillant.—*Fowlerina* est donc distinct de l'un et de l'autre.

Remarques sur les diverses Espèces de Clionidæ.

1°. Parmi les *Clione*:

(*a*) *Clione limacina* est dépourvu de chromatophores et possède 3 paires de céphalocônes et des sacs à crochets à dents longues;

(*b*) *Clione aurantiaca*, Gegenbaur, *C. longicaudata*, Souleyet (Atlantique), et *C. caudata*, MacDonald (Sydney), sont pourvus de chromatophores, de 2 paires de céphalocônes et de sacs à crochets à dents courtes;

(*c*) enfin *C. punctata*, Tesch, est pourvu de chromatophores, et d'une paire de céphalocônes, ses radula et sacs à crochets demeurant inconnus.

2°. Je suis porté à croire: (α) que les *Clione* sub littera *b*, se rangeront dans le genre *Paraclione*, caractérisé par 2 paires de céphalocônes, à sacs à crochets courts, et à chromatophores;

(β) que *C. punctata* serait probablement un *Fowlerina*;

* Kwietniewski: "Contribuzioni alla conoscenza anatomo-zoologica degli Pteropodi Gimnosomi," Rich. Lab. Anat. Roma, vol. ix. p. 78.

† Mais en une soi-disante "*Clio*" MacDonald décrit une mandibule ("On the Zoological Characters of the living *Clio caudata*, as compared with those of *Clio borealis* given in Systematic Works," Trans. Roy. Soc. Edinb. vol. xxiii. pl. 9. fig. 3 *d*).

(γ) que *Clione limacina* (et peut-être *C. antarctica*, Smith) représente seul le genre *Clione*.

V. Lamellibranche.

17. Une larve indéterminable, avec 6 filaments branchiaux.
Occurrence. 34 *a*. 25 to 0 fathoms. 1 specimen.

B. BIONOMIQUE.

Une partie des organismes recueillis appartiennent à la zone superficielle, s'étendant jusqu'aux environs de 100 fathoms: c'est l' "epiplancton." Une autre partie est propre à une zone plus profonde, au-dessous des environs de 100 fathoms: c'est le "mésoplancton" (*Fowler*).

1. Epiplancton.

Il comprend, 1°, des formes *in situ*; c'est-à-dire eupélagiques ou holoplanctoniques; 2°, des formes larvaires appartenant à des organismes benthoniques à l'état adulte, c'est-à-dire des formes hémipélagiques ou mésoplanctoniques.

1°. *Eupélagiques.* Ce sont: A, *Carinaria*; B, la plus grande partie des Thécosomata (*Peraclis* excepté); C, le Gymnosome *Fowlerina*, qui paraît nyctipélagique.

2°. *Hémipélagiques.* Ce sont les larves de Gastropodes et de Lamellibranche, toutes recueillies, d'une façon générale, entre 50 et 0 fathoms.—La détermination d'un certain nombre des larves de Gastropodes démontre qu'elles appartiennent à des adultes *abyssaux* (*Columbella*, *Solarium*, *Natica*, *Coralliophila*?, etc.), confirmant ainsi la supposition faite il y a près de cinquante ans par MacDonald *.

2. Mésoplancton.

A ce groupe appartient seulement le genre *Peraclis*.

J'ai déjà noté en 1888 † que, dans la Méditerranée, ce genre habite en-dessous de 100 mètres de profondeur.—Tesch a constaté que les 3 espèces de *Peraclis* prises par le 'Siboga' ne proviennent que d'une *seule* station (St. 243); mais il ne remarque pas qu'elles sont obtenues dans une prise *très profonde* (filet vertical de Hensen depuis 1000 mètres).

De même, de tous les exemplaires de la 'Research' (18 stations), *pas un seul* n'a été pris dans les nombreuses pêches où le filet était enfoncé seulement jusqu'à 50 brasses de la surface (sauf 1 seul spécimen pris la nuit: 30 *l*). *Tous* les autres ont été recueillis quand le filet avait été enfoncé jusqu'à 100, 150, 250, 350, 400, 1000 brasses ou davantage.

Peraclis est donc un genre caractéristique du mésoplancton ou de la faune zonaire, et ne se rencontre jamais vers la surface. Il n'est connu jusqu'ici que dans les régions tropicales ou tempérées et n'y constitue nullement une forme superficielle polaire qui s'est enfoncée.

* Trans. Linn. Soc. vol. xxii. p. 241.

† "Report on the Pteropoda," Zool. 'Challenger' Exped. pt. lxv. p. 35.

EXPLICATION DES PLANCHES.

Planche 10.

Fig. 1. *Coralliophila* (?), sp. A. Coquille larvaire, vue ventrale. × 21.
2. Coquille larvaire, vue dorsale. × 21.
Fig. 3. *Coralliophila* (?), sp. B. Coquille larvaire, vue ventrale. × 21.
4. Opercule, face extérieure. × 50.
Fig. 5. *Columbella haliaëti*, Jeffreys. Coquille larvaire, vue ventrale. × 21.
6. Larve, vue dorsale. × 21.
7. Larve, vue ventrale. × 21.
8. Opercule, face extérieure. × 96.
9. Une rangée transversale de la radule de la larve. × 590.
Fig. 10. *Solarium*? sp. Coquille larvaire, vue ventrale. × 50.
11. Opercule, face extérieure. × 96.
Fig. 12. *Natica* (*Lunatia*) sp. Coquille larvaire, vue ventrale. × 21.
13. Une rangée transversale de la radula de la larve. × 810.
14. Larve hors de sa coquille, vue orale. × 20.
15. Opercule, face extérieure. × 50.
Fig. 16. Première coquille larvaire d'un Lamellariide, vue ventrale. × 21.
17. Vue latérale gauche de la même. × 21.
18. La larve hors de sa première coquillle, vue ventrale. × 21.
19. Vue antérieure du velum étendu de la même larve. × 21.
Fig. 20. *Lamellaria*, larve A. Première coquille larvaire, vue ventrale. × 21.
21. Première coquille larvaire, côté gauche. × 21.
Fig. 22. *Lamellaria*, larve B. Première coquille larvaire, vue ventrale. × 21.
23. Première coquille larvaire, côté gauche. × 21.

Planche 11.

Fig. 24. *Lamellaria*, larve B. La larve, hors de sa première coquille larvaire, avec son velum étendu ; vue orale. × 40.
Fig. 25. *Lamellaria*, larve A. Une rangée transversale de la radula. × 810.
26. La même larve, retirée de sa première coquille larvaire ; côté gauche. × 50.
27. La même larve, vue du côté droit. × 50.
Fig. 28. *Lamellaria*, larve B. Mandibules. × 250.
29. Une rangée transversale de la radule de cette larve. × 450.
Fig. 30. *Carinaria* sp. Coquille larvaire, vue ventrale. × 21.
31. Une larve âgée, hors de sa coquille, vue du côté droit. × 21.
32. Un jeune individu immature ; côté gauche. × 21.
33. Nageoire métapodiale de ce jeune, vue ventrale. × 40.
34. Coquille larvaire, vue du côté columellaire. × 21.
35. Coquille larvaire, côté apical. × 21.
36. Larve hors de sa coquille, côté gauche. × 21.
37. Opercule de la larve, face extérieure. × 60.
38. Vue orale du velum étendu de la larve. × 26.
39. Une rangée transversale de la radula de la larve (dent centrale et dents latérale et marginale gauches). × 450.
40. Larve dans sa coquille, vue dorsale. × 21.

Fig. 41. *Peraclis triacantha*, Fischer, hors de sa coquille, vue dorsale. × 25.
42. Opercule, face extérieure. × 50.
44. Une rangée transversale de la radula. × 810.

Planche 12.

Fig. 43. *Peraclis triacantha*. Quelques dents de deux rangs de la mandibule. × 810.
Fig. 45. *Peraclis brevispira*, sp. n. Trois dents d'un rang de la mandibule. × 810.
46. Coquille, vue dorsale. × 21.
Fig. 47. *Peraclis triacantha*. Une dent latérale de la radula, vue ventrale. × 450.
Fig. 48. *Peraclis brevispira*. Une dent latérale de la radula, vue ventrale. × 810.
49. La coquille avec son opercule, vue ventrale. × 21.
Fig. 50. Section sagittale schématique de *Peraclis*.
Fig. 51. *Peraclis brevispira*. Vue apicale de la coquille. × 36.
Fig. 52. Section sagittale schématique de *Actæon*.
Fig. 53. *Fowlerina Zetesios*, gen. et sp. nn., vue ventrale. × 9.
54. Vue ventrale d'un autre spécimen. × 21.
55. Vue ventrale d'un 3e spécimen, avec la trompe dévaginée. × 21.
56. Vue orale de la tête. × 21.
57. Une rangée transversale de la radula. × 250.
58. Les crochets d'un sac à crochets. × 96.
59. Vue orale d'un spécimen. × 21.
60. Mandibule, vue ventrale. × 300.

Lettres communes aux trois Planches.

a. = anus.
a.l. = lame accessoire.
au. = oreillette.
ba. = balancier.
b.m. = masse buccale.
bo. = corps.
bu. = ganglion buccal.
c. = dent centrale.
ce. = céphalocônes.
co. = muscle columellaire.
e. = œil.
f. = pied.
fi. = nageoire.
fi.' = nageoire métapodiale.
f.g. = sillon pédieux.
g. = branchie.
g.o. = orifice génital.
h. = tête.
ho. = capuchon céphalique.
h.s. = sacs à crochets.
in. = intestin.
k. = rein.
l. = dent latérale.
la. = larve.
li. = foie.
m., m.' = dents marginales.
ma. = mandibules.
me. = métapodium.
mo. = bouche.
o. = ouverture de la coquille.
œ. = œsophage.
o.l. = lobe pédieux operculigère.
op. = opercule.
os. = osphradium.
p. = pénis.
pa. = manteau.
pa.g. = glande palléale.
p.c. = chambre palléale.
p.g. = ganglion pédieux.
pr. = trompe.
r. = rostre ventral de l'ouverture de la coquille.
ra. = radula.
sh. = coquille.
si. = siphon.
su. = ventouse.
t. = tentacule.
v. = velum.
v.a. = lobe antérieur du velum.
v.d. = partie droite du velum.
vi. = masse viscérale.
v.p. = lobe postérieur du velum.
v.s. = partie gauche du velum.

NOTE ON THE DISTRIBUTION OF THE MOLLUSCA.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S., F.Z.S.*

The chief thing noticeable about the distribution of these species is their rarity at the actual surface. Out of seventeen distinguishable forms, only three were taken at the surface, and all three were more plentiful at lower horizons of the epiplankton.

On the other hand, between 25 and 100 fathoms inclusive, despite the sparse population as evidenced by the small number of total specimens, the captures were numerous. Mollusca occurred:

At 25 fathoms	in 75 per cent. of the hauls.
„ 50 „	„ 84 „ „
„ 75 „	„ 72 „ „
„ 100 „	„ 63 „ „
„ all depths, 25–100 fms.	„ 72 „ „

Few species occurred in sufficient numbers or with sufficient regularity to allow of an accurate study of their distribution, and only one could be regarded as common at the surface; but four were sufficiently plentiful to justify an analysis of their occurrences *.

Carinaria sp.

	fathoms, this form occurred in	per cent. of the hauls, with	average specimens per hour haul.
At 0	25	0·6	
25	50	1·0	
50	61	2·5	
75	36	0·5	
100	31	0·6	

Below 100 fathoms it occurred in no haul of the closing-net. We may fairly conclude that this form was epiplanktonic, with an optimal horizon at 50 fathoms.

When tried on the time-depth table, there was no indication of vertical oscillation; again, when tested on a "day, night, and rain" table (compare *supra*, pp. 60, 61), it was not obvious that the distribution was affected by light, darkness, or rain. But the actual numbers captured were too small to allow of certainty on this point.

Peraclis brevispira, sp. n.

	fathoms, this species occurred in	per cent. of the hauls, with	average specimens per hour haul.
At 0	0	0·0	
25	0	0·0	
50	7	0·07	
75	0	0·0	
100	50	1·4	

* As in previous analyses, the nine hauls with a small fine-meshed net have been omitted, and the captures multiplied by a time-factor (compare the second footnote on pp. 50 and 60).

It would seem from this table that the species was a member of the lower epiplankton, and as it was taken also in three hauls with a closing-net out of seven such hauls which contained Mollusca, and as it was not so plentiful above as to fill the mid-water with dead specimens, it is very probable that it ranges also into the mesoplankton, as low as the zone of 1000-750 fathoms.

Clio pyramidata, Brown.

	fathoms, this species occurred in	per cent. of the hauls, with	average specimens per hour haul.
At 0	0	0·0	
25	16	0·1	
50	53	1·5	
75	27	0·2	
100	27	0·6	

This species, like the preceding, appeared to belong to the lower epiplankton, but with an optimal horizon of 50 fathoms. It is possible that it extends below the hundred-fathom horizon, having twice been taken in a closing-net.

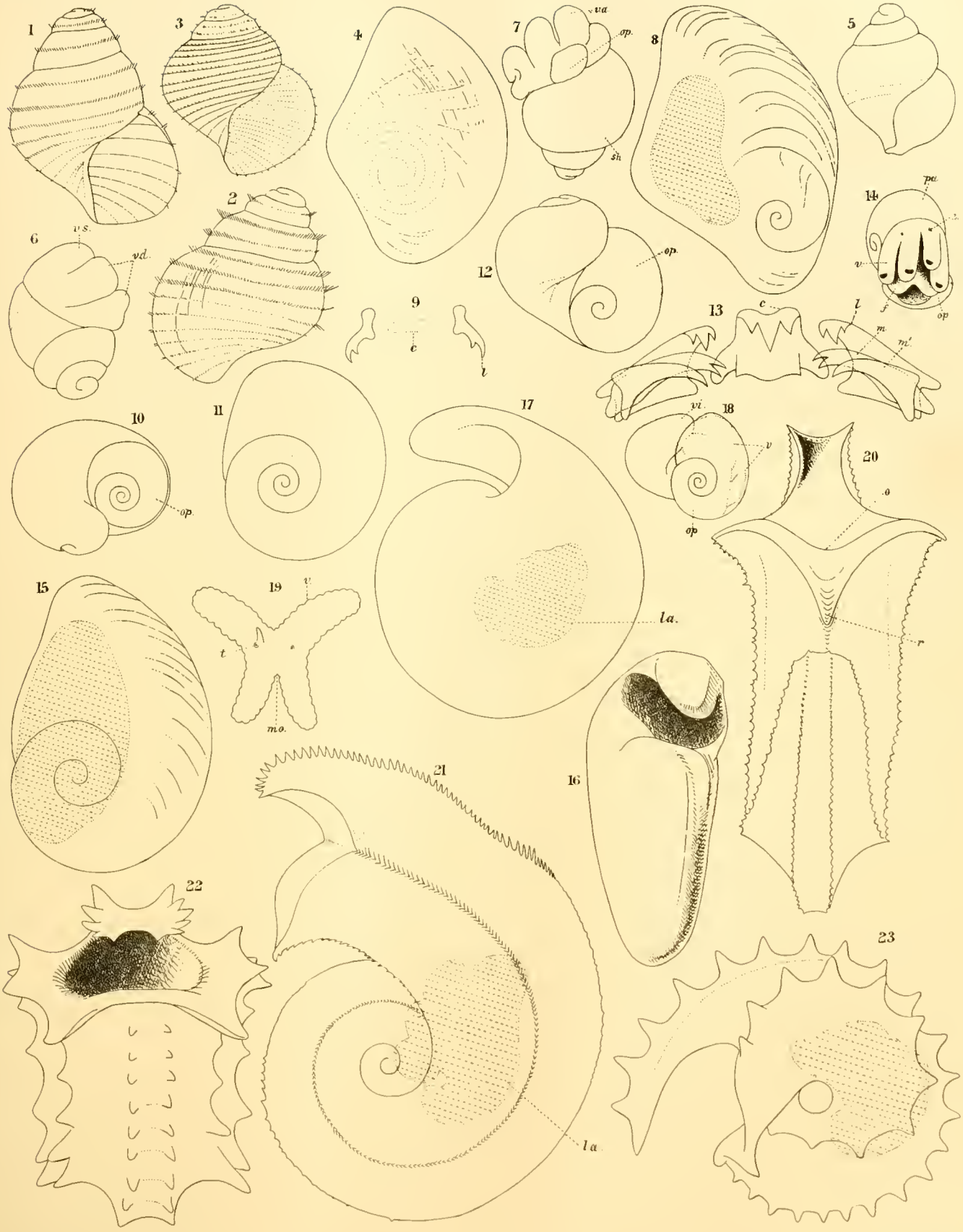
Cavolinia inflexa, Lesueur.

	fathoms, this species occurred in	per cent. of the hauls, with	average specimens per hour haul.
At 0	12	0·1	
25	16	0·5	
50	46	1·7	
75	27	1·0	
100	18	0·1	

Unlike the last, this species was captured at the actual surface, and seemed to show an optimal zone of 75–50 fathoms. The single capture at 1500–1250 fathoms, in the absence of any intermediate captures higher in the mesoplankton, can hardly be taken to indicate any extension into the mesoplankton.

Depth in fathoms.	Haul.	*Coralliophila* (?), sp. A.	*Coralliophila* (?) sp. B.	*Columbella haliaëti.*	*Solarium* sp.	*Natica* sp.	*Lamellaria*, sp. A.	Lamellariid.	*Lamellaria*, sp. B.	*Carinaria* sp.	*Peracle triacantha.*	*Peracle brevispira.*	*Limacina retroversa.*	*Clio pyramidata.*	*Clio cuspidata.*	*Cavolinia inflexa.*	*Fowlerina setosus.*	Lamellibranch larva.
500—250	29 *a*																	
1500—750	30 *a*																	
2000—1000	30 *e*																	
0	21 *e*	..	..	..	..	..	..	..	..	1								
	21 *f*																	
	21 *i*																	
	22 *d*																	
	22 *e*																	
	22 *g*																	
	23 *b*																	
	23 *c*	..	..	..	..	..	..	..	..	1								
	23 *d*	..	..	..	..	..	..	..	..	..	..	..	1	..	..	2		
	23 *e*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1		
	24 *c*																	
	24 *f*																	
	24 *g*	..	..	..	..	..	..	..	..	4								
	24 *h*																	
	24 *i*	..	..	..	..	..	..	..	..	4								
	24 *k*	..	..	..	..	..	..	..	..	1								
	25 *a*																	
	25 *b*																	
	25 *h*	..	..	..	..	..	..	..	..	1								
	25 *i*																	
	25 *l*																	
	30 *c*																	
	32 *c*																	
	33 *a*																	
	33 *b*																	
25—0	26 *a*	..	..	..	..	..	..	..	..	5								
	30 *b*																	
	30 *m*																	
	31 *a*	..	..	..	..	..	..	..	..	1								
	32 *b*	..	..	..	..	..	..	..	..	2								
	32 *c*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4		
	33 *e*	..	1															
	33 *g*	1	1	2	1	1	1	..	..	1	..	..	..	1	2			
	34 *a*	..	2	..	..	..	..	..	..	2	..	..	..	1	..	..	1	1
	34 *g*																	
	35 *w*	..	1	..	..	..	..	..	..	..	..	..	..	..	..	2		
	36 *c*	..	..	..	..	..	..	..	..	1								
50—0	21 *g*	..	..	..	..	..	..	..	..	..	..	..	..	1				
	25 *e*	..	..	..	..	..	..	..	..	1								
	25 *g*	..	..	..	2	..	..	..	..	4	..	..	1	2	..	5		
	25 *k*	..	..	..	..	..	..	..	..	2	..	..	..	3				
	26 *c*	..	..	..	..	..	..	..	..	1								
	30 *d*	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1		
	30 *l*	..	1	6	..	..	..	..	..	5	..	1	..	5	..	2	1	
	31 *b*	..	..	4	1	1	..	..	..	16	..	..	3	5	..	10		
	32 *a*	1	1	2	..	..	..	..	..	3	..	..	..	..	..	2		
	32 *h*	..	..	..	..	..	..	..	1	..	..	..	..	..	..	3		
	33 *c*																	
	33 *f*	..	..	..	..	..	..	..	..	1	..	..	..	2				
	36 *d*																	
75—0	30 *f*																	
	32 *g*	..	..	..	..	..	..	..	..	1								
	32 *m*	..	..	..	..	..	..	1										
	32 *o*	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1		
	33 *h*	..	..	..	..	..	..	..	..	1	..	..	..	1				
	34 *c*	..	..	1	..	..	..	..	..	..	..	..	..	1	..	3		
	35 *a*																	
	35 *c*																	
	35 *c*	..	..	..	..	..	..	..	..	2	..	..	..	..	..	8		
	35 *y*	..	..	..	..	..	..	..	..	2								
	36 *a*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	

Depth in fathoms.	Haul.	*Cordiliphila* (?), sp. A.	*Cordiliphila* (?), sp. B.	*Columbella haliaëti.*	*Solarium* sp.	*Natica* sp.	*Lamellaria*, sp. A.	Lamellariid.	*Lamellaria*, sp. B	*Cavinaria* sp.	*Peractis triacantha.*	*Peractis brevispira.*	*Limacina retroversa.*	*Clio pyramidata.*	*Clio cuspidata.*	*Cavolinia inflexa.*	*Fowlerina zetesos.*	Lamellibranch larva.
100—0	21 *h*	..	..	..	..	1	..	..	..	3								
	21 *l*																	
	22 *a*																	
	24 *b*	..	..	..	..	1	..	..	..	2	..	1	..	..	..	1		
	24 *d*																	
	24 *e*	..	..	..	..	..	..	..	..	..	..	..	1					
	25 *d*	..	..	..	..	..	..	..	..	..	..	1						
	30 *g*	..	..	1	..	..	..	..	..	..	..	6	..	1	..	1		
	30 *h*	..	..	..	..	..	..	..	..	..	..	12	1	3				
	32 *d*	..	..	1	..	..	..	..	..	1	..	2	4	3	..	1		
	32 *i*	..	..	..	..	..	..	..	..	1	..	1	..	..	..	1		
	32 *n*	..	..	..	..	..	..	..	..	3	..	1						
	32 *p*																	
	33 *d*																	
	34 *b*	..	..	..	..	..	..	..	..	1	1	1	..	1				
	34 *d*	..	..	1	..	..	..	..	..	..	..	1	..	5				
	35 *b*	..	..	..	..	..	..	..	..	..	..	..	1	1				
	35 *d*																	
	35 *f*																	
	35 *x*																	
	36 *b*	..	..	1	..	..	..	..	..	1	..	1	..	..	..	..	1	
	36 *e*	..	..	..	..	..	..	..	..	..	..	13						
150—0	36 *f*	..	..	..	..	..	..	.	..	..	..	1						
150—50	21 *p*																	
150—100	21 *n*																	
200—0	21 *a*																	
	36 *g*	..	..	..	..	..	..	..	..	..	..	..	1	2				
200—100	21 *b*																	
	21 *o*																	
	26 *e*																	
	34 *h*																	
	35 *m*																	
	35 *n*																	
	35 *t*																	
250—0	36 *h*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	
	36 *i*	..	..	..	..	..	..	..	..	..	..	..	..	..	1			
250—150	35 *o*	..	..	..	..	..	..	..	..	..	..	1						
	35 *p*																	
	35 *s*	..	..	..	..	..	..	..	..	..	..	..	..	1				
300—0	36 *k*																	
300—200	21 *c*																	
	26 *f*																	
	35 *l*																	
350—0	36 *l*	..	..	..	..	..	..	..	..	1	1	7	..	1	1	..	1	
400—300	21 *k*	..	..	..	..	..	..	..	..	..	..	1	..	2				
	32 *l*																	
	35 *k*																	
500—400	21 *m*																	
	35 *h*																	
	35 *i*																	
750—500	22 *b*																	
	30 *k*																	
	34 *e*	..	..	2														
	34 *f*																	
1000—750	23 *a*	..	..	..	..	..	..	..	..	..	..	1						
	27 *c*																	
	31 *d*																	
	32 *f*																	
	32 *k*																	
1250—1000	24 *a*																	
	27 *b*																	
	31 *c*																	
1500—1250	25 *f*																	
	30 *i*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1		
2000—1500	25 *c*																	
	26 *b*																	



P. Pelseneer del.

M.P. Parker lith. Parker & Wood imp.

BISCAYAN MOLLUSCA.

P. Pelseneer del.

M. P. Parker lith.
Parker & West imp.

BISCAYAN MOLLUSCA

BISCAYAN MOLLUSCA

BISCAYAN PLANKTON.

Part VIII.—THE CEPHALOPODA.

By William E. Hoyle, *Director of the Manchester Museum.*
(*Communicated by* Dr. G. Herbert Fowler, *F.L.S.*)

(With 3 Text-figures.)

Read 7th June, 1906.

The small collection of Cephalopods entrusted to me for examination by my friend Dr. Fowler consisted entirely of young specimens, many too young to enable the species to be determined with certainty, although the state of preservation was excellent.

Most of the examples I have submitted to my friend Dr. Pfeffer, of Hamburg, who has made a special study of these immature forms, and I am greatly indebted to him for giving me the benefit of his opinion.

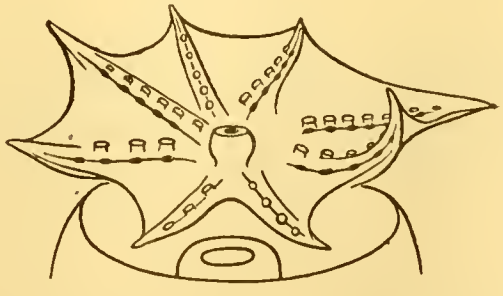
The numbers preceded by "H" in square brackets refer to my own register.

Eledonella sp.

Locality: 32 *i*, July 21, lat. 47° N., long. 7° 38′ W.; depth, surface to 100 fathoms; temperature, 52° to 64° F.; one specimen [H 1066].

This specimen is undoubtedly the young of some species of *Eledonella* or possibly *Japetella*; the only noteworthy peculiarity it presents is that the arms of the second pair are a little longer than those of the third. The suckers and the circumoral lip are very dark, almost black. In the centre of the transparent arm is seen a slender black

Fig. 1.



thread, upon which is a fusiform swelling under each sucker (see fig. 1); this is presumably the nerve-cord with a series of ganglia.

The present specimen extends the distribution of the genus to the Eastern Atlantic;

the previously recorded localities have been as follows :—North of New Guinea ('Challenger,' Station 220); off the Marshall Islands ('Albatross,' Station 220, 1900); in the Gulf of Panama ('Albatross,' Stations 3366, 3415, and 3420, 1891); off the New England Coast ('Albatross,' Station 2099, 1883).

Chun (Verh. deutsch. zool. Ges. vol. xii. pp. 162–182, 1902) has expressed the opinion that *Eledonella* and *Bolitæna* are synonymous, but, so far as I am aware, he has not published the grounds for this view.

Onychoteuthis sp.

Locality: 31 *b*, July 20; lat. 47° 15′ N., long. 7° 41′ W.; depth, surface to 50 fathoms; temperature, 52° to 64° F.; two specimens [H 1064, 1065].

The appearance of the larger of these two specimens, which measures a little over 5 mm. in length, is shown in the accompanying figure (fig. 2). Of special interest is

Fig. 2.

the small size of the fin in these immature stages, to which attention has already been called by Pfeffer ("Synopsis œgopsid. Ceph.," Mitt. naturhist. Mus. Hamburg, vol. xvii. p. 159, 1900). The tentacles also are seen to be present only as minute rudiments, contrasting strongly with the more developed arms.

Teleoteuthis caribbæa (Lesueur).

Locality : 30 *l*, July 19; lat. 47° 14′ N., long. 7° 58′ W.; depth, surface to 50 fathoms; temperature, 52° to 64° F.; two specimens [H 1062, 1063].

This species appears to be one of the commonest and most widely distributed of all pelagic forms. It has been found pretty frequently both in the Atlantic and Pacific Oceans, but the records from the Mediterranean require confirmation.

A character often noticeable in the young stages is a pair of conspicuous chromatophores, which appear as elongated spots in a latero-ventral position halfway along the fin. These are not seen, however, in either of the examples now under notice; they are both very dark in colour, and perhaps the spots have been masked by a rearrangement of the chromatophores.

Teleoteuthis sp.

Localities: 30 *b*, July 19; lat. 47° 14′ N., long. 7° 58′ W.; depth, surface to 25 fathoms; temperature, 54° to 64° F.; one specimen [H 1058].

35 *w*, July 24; lat. 47° 8′ N., long. 7° 54′ W.; depth, surface to 25 fathoms; temperature, 54° to 65° F.; one specimen [H 1070].

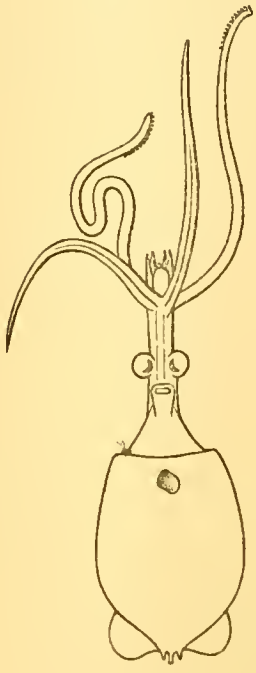
36 *k*, July 25; lat. 47° 3′ N., long. 7° 55′ W.; depth, surface to 300 fathoms; temperature, 51° to 66° F.; two specimens [H 1071, 1072].

Doratopsis sp.

Locality: 34 *f*, July 23; lat. 46° 43′ N., long. 7° 15′ W.; depth, 500 to 750 fathoms; temperature, 48° to 49° F.; one specimen [H 1069].

This specimen, which measures not quite 20 mm. in total length, has been identified by Dr. Pfeffer, who possesses a fine series of young forms belonging to this genus.

Fig. 3.



Although it was much distorted I have restored it to the best of my ability, and give an outline sketch (fig. 3), which shows some of its more striking characters. The body is swollen and barrel-shaped, whereas the smallest example which has hitherto been figured (Ficalbi, Monit. Zool. Ital. vol. x. 1899, p. 99) has the mantle tubular with almost parallel sides.

Cranchia megalops, Prosch.

Localities: 24 *d*, July 11; lat. 47° 5′ N., long. 7° 45′ W.; depth, surface to 100 fathoms; temperature, 52° to 63° F.; one specimen [H 1057].

30 *g*, July 19; lat. 47° 14′ N., long. 7° 58′ W.; depth, surface to 100 fathoms; temperature, 52° to 64° F.; three specimens [H 1059, 1060, 1061].

34 *b*, July 23; lat. 46° 43′ N., long. 7° 15′ W.; depth, surface to 100 fathoms; temperature, 52° to 65° F., one specimen [H 1067].

This species has been hitherto recorded from the neighbourhood of the Færoe Islands and Greenland; I am not acquainted with any records so far south as those here given. All the examples hitherto examined are very small, and it is highly probable that they are immature and that the fully developed form has still to be discovered.

Cranchiidarum gen. et sp. ?

Locality: 34 *d*, July 23; lat. 46° 43′ N., long. 7° 15′ W.; depth, surface to 100 fathoms; temperature, 52° to 65° F.; one specimen [H 1068].

This is a small larval form measuring only about 3 mm. in total length; it is impossible to determine the genus to which it should be referred.

Embryo.

Locality: 32 *m*, July 21; lat. 47° 0′ N., long. 7° 38′ W.; depth 0 to 75 fathoms; temperature, 52° to 64° F.

An embryo with yolk-sac attached was brought from this locality.

BISCAYAN PLANKTON.

Part IX.—THE MEDUSÆ.

By Edward T. Browne, *B.A., Zoological Research Laboratory, University College, London.*

(*Communicated by* Dr. G. Herbert Fowler, *F.L.S.*)

(Plate 13.)

Read 7th June, 1906.

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Introduction.

The Medusæ which Dr. Fowler collected during his expedition to the Bay of Biscay in 1900 were kindly handed over to me for examination. I have worked through his collection with much interest. After working several years on the medusoid fauna of the British Isles, I was particularly anxious to learn something about the medusæ which live in the Atlantic beyond our hundred-fathom line. There have been many expeditions to the deep water off our western coasts, but, for some reason or other, the medusæ have usually been forgotten, so that the records of capture beyond the hundred-fathom line are rather scarce.

Dr. Fowler selected the northern side of the Bay of Biscay for his explorations, and worked in the neighbourhood of latitude 47° N. and a little to the westward of longitude 7° W., where he was able to let down his nets to 2000 fathoms. He made 138 separate hauls with tow-nets, and out of these I received specimens from 88 hauls.

I have been able to identify fifteen genera and ten species, but have failed to identify specimens belonging to several different genera owing to their mutilated condition. Unfortunately, nearly all the specimens taken in the deep hauls below 500 fathoms were in bad condition, and several were quite unrecognizable.

The Trachomedusæ predominated over all the other orders. Six genera were recognized, and at least two more were present, but not in a recognizable condition. Three species formed about 85 per cent. of the specimens in the collection. These were *Aglantha rosea* (42 per cent.), *Aglaura hemistoma* (27 per cent.), and *Rhopalonema cæruleum* (15 per cent.). Among the rarities I may mention *Trachynema eurygaster*, which belongs to the fauna of the Mediterranean and the warm water of the Atlantic; *Colobonema sericeum*, one of the new deep-sea medusæ discovered by the 'Valdivia' in the Gulf of Guinea and the Indian Ocean; and some large adult specimens of *Homœonema platygonon*. I expected to see at least one species of *Liriope* in the collection, as the species of this genus are common and widely distributed over the Atlantic; but their natural habitat is no doubt in the warm water. Occasionally they do drift up the English Channel and along the west coast of Ireland.

The Narcomedusæ were uncommonly scarce. Three genera were recognized, and at least two more genera from out of the unrecognizable genera may be allotted to this order. There is, however, a species which I believe has not hitherto been described. It belongs to the genus *Cunoctantha*, and the species is named in compliment to Dr. G. H. Fowler. It has a number of medusa-buds showing various stages of development upon the pouches of the stomach. Other species of *Cunoctantha* and *Cunina* are known to have medusa-buds; but at this stage the buds are really parasites, developing either directly or indirectly from the eggs of another medusa, or they may arise from curious neutral amœboid cells such as those which Metschnikoff has described for *Cunina proboscidea*. The medusa-buds in this new species develop from outgrowths of the walls of the stomach, presenting a straightforward case of asexual gemmation, such as is found in some of the Anthomedusæ.

The Scyphomedusæ were also very scarce. The collection contains a single specimen

of *Atolla*, one of those medusæ which are generally found at great depths and in cold water; and two early stages of a *Periphylla*, which is another medusa belonging to the deep and cold zone.

The Anthomedusæ are represented by a single species, namely, *Margelis autumnalis*, and the Leptomedusæ by two species—*Obelia lucifera* and a *Tima*. The occurrence of these medusæ so far from the coast is no doubt due to a surface-drift. They are neritic species which have gone astray. Fragments of the common littoral hydroid *Campanularia flexuosa* were also taken in the tow-net.

Comparison with the Medusæ recorded for the English Channel.

I should not have attempted a comparison with the medusæ of the English Channel, but for the results which have been obtained by an investigation of the plankton of the Channel by the Staff of the Marine Biological Association at Plymouth. In 1903 a series of quarterly cruises was begun in connection with the International Fisheries Investigations. On these cruises series of tow-nettings are taken at definite stations, some of which have been arranged to cover the entrance to the Channel.

Until the cruises began our knowledge of the Channel medusæ was limited to those found about twelve miles from shore, consequently nearly all the species which have been recorded belong either to the Anthomedusæ or Leptomedusæ; a list compiled for these two orders gives about forty-five species. The Trachomedusæ are represented by only two species, namely, *Liriope* (*Liriantha*) *tetraphylla*, which occasionally comes in shoals, and *Gossea corynetes*, which is rather scarce. The Narcomedusæ are seldom seen close in shore, and only one species (*Solmaris corona*) has been recorded.

The results obtained on the quarterly cruises for the years 1903, 1904, and the first half of 1905 have been rather disappointing so far as medusæ are concerned. Up to the present *Aglantha rosea* is the only new addition to the list. I certainly expected to see a greater increase of species among the Trachomedusæ and Narcomedusæ.

Gough (1905) in his account of the distribution of individual species in the Channel says: "a comparison of the ranges of the single plankton-elements demonstrates the fact that the oceanic species invade the Channel from the south-west, and become rarer as they advance up the Channel." Now Dr. Fowler's stations lie in the track of medusæ invading the Channel from the south-west, so one would expect to find some of the Biscayan species at the mouth of the Channel. For a comparison it is necessary to omit the species which are known at great depths, and select only those which occur within 100 fathoms of the surface, as the depths of the Channel stations do not exceed 90 fathoms. We have then the following three species—*Aglantha rosea*, *Aglaura hemistoma*, and *Rhopalonema cœruleum*—living within 100 fathoms of the surface in the Bay of Biscay. *Aglantha rosea* has succeeded in entering the Channel, but the other species have not. The records, up to the present, of the medusæ taken at the entrance of the Channel are distinctly in favour of the neritic forms. It appears that the oceanic species only now and again drift within the Channel area.

Previous Records for the Bay of Biscay.

In searching for records of medusæ taken far away from shore in the Bay of Biscay I have not been very successful, and have probably failed to find some that have been made. In the Report by Maas (1904) on the collections made by the Prince of Monaco there are three records for the Bay, namely, *Æquorea forskalea*, *Agliscra elata*, and *Atolla bairdii*. These were all found on the southern side of the Bay, off the north coast of Spain.

On Collecting and Preserving Medusæ.

The following methods for collecting and preserving medusæ have been used by me for several years. I publish them now with the hope that they may be useful and helpful to naturalists who go abroad to collect plankton, or to make general collections, and, finding some medusæ, would like to know how to preserve them in fairly good condition. I take into consideration the difficulties of working in a limited space on board a ship, and also in having to get through the work with limited chemicals, vessels, and time. On this account I omit methods more suitable for use in a properly equipped laboratory on shore, and methods suitable for histological work.

Collecting Medusæ.—A small flat hand-net made of bolting-silk is a useful implement for catching medusæ which can be seen swimming at the surface. Its use, however, is practically limited to a small boat in sheltered waters. The medusæ can be gently lifted from the sea, and at once placed in a jar of sea-water without receiving any damage.

Of tow-nets there are many kinds, some of which are responsible for the mutilation of jelly-fish. The best kinds are those with a long cone-shaped net with a can attached to the end. The bad kinds are those without a can at the end, and, worst of all, are certain kinds of closing-nets.

As a guide, I give the size of the net which I generally use from a rowing-boat. It has a circular mouth of 17 inches in diameter, and the net is about 5 feet in length, gradually tapering down to $3\frac{1}{2}$ inches in diameter, which is the diameter of the zinc can attached to the end of the net. The nets are made of bolting-silk. Three nets form the series, having respectively 30, 50, and 76 threads per inch. It is a mistake to use a very fine-meshed net (about 150 threads per inch), unless one is seeking for diatoms and other microscopic organisms.

The old-fashioned bag-shaped net, without a can at the bottom, is very liable, unless pulled very slowly through the water, to damage delicate animals. The plankton collects in a mass at the bottom of the net, and the pressure of the water against this resisting mass crushes and mutilates the specimens.

The closing-nets used for deep-sea investigations, and worked by various mechanical devices for opening and closing the mouth, are frequently made so that when the mouth is closed the sides of the net come together. It appears to me that in hauling up the net from great depths, especially when the ship is rolling, the sides of the net rub together, and consequently the animals inside get seriously damaged. The medusæ

taken in Dr. Fowler's closing-nets were badly damaged, and many specimens had the ectoderm and endoderm completely rubbed off. I would suggest that these nets be fastened on to a series of hoops, so as to prevent the sides from coming together when the mouth is closed.

The speed of towing the net is a very important matter when jelly-fish are wanted in good condition. As a rule, the net is towed too fast. When using my own net, of the size mentioned above, from a rowing-boat, I know that the speed is about right so long as I can comfortably hold the line on one finger. I once tested the pull with a spring balance, and found that a pull of about three pounds was quite sufficient. If one tows too fast the water banks up in front of the net and the animals shoot off to the sides, and most of them pass outside the net.

When working a tow-net from a steamboat or a sailing-boat there is nearly always the difficulty of regulating the pace of the boat. Even with the sails down or the engines stopped a light breeze soon causes the boat to drift too fast, and then comes a strong pull and a heavy strain which crushes the animals against the meshes of the net. Dr. Fowler has just designed a tow-net to close as the pressure increases. Its design is most ingenious, and its construction is so simple that there is no mechanism to get out of order. I feel sure that this kind of net will be most useful to those who have to work from steamboats or sailing-boats.

Preserving Medusæ.—The wrong method, and the one which I believe from the appearance of specimens is most frequently used, is to strain off the water and then place the whole bulk of the plankton in a small bottle with a little formalin or alcohol. I have no doubt that this method answers fairly well for animals which have a hard coat, or for organisms such as diatoms; but it is ruinous for a medusa or for any other soft-bodied animal. A medusa treated by this method is either squashed fairly flat, or is badly contracted and out of shape. It is frequently mutilated and more or less macerated. For the description and identification of medusæ it is really necessary that some of the specimens should be in good condition.

When the net is taken on board, the contents of the can should be poured into one or more glass vessels; the medusæ picked out and transferred to another glass vessel, which must be perfectly clean and free from chemicals. At first the medusæ are generally in a contracted condition, and if preserved at once they die contracted. It is now best to place the vessel aside for half an hour or a little longer, and, in the meanwhile, look after the other members of the plankton. During the interval most of the medusæ, unless badly damaged, will have recovered from the shock, and will be seen slowly pulsating and swimming about. If they should be crowded in a heap on the bottom of the vessel, a slow stir round with a clean glass rod induces them to swim and expand. The medusæ may be left in the vessel for two or three hours, if other work should be more pressing and important, but an occasional stir round is beneficial. If the medusæ after the first half-hour look in a sickly condition, the sooner they are preserved the better; but if in a healthy condition, there is no need to hurry over the preservation.

The simplest and quickest method for preserving either a few specimens or several dozen is the pouring of diluted formalin into the sea-water; but the secret of success

lies in the manner in which this is done. The strength of the formalin should be about 5 to 10 per cent. (5 per cent. solution containing 5 cc. of formaldehyde, 40 per cent. strength, and 95 cc. of water—either fresh water or sea-water may be used). The quantity of formalin to be poured into the vessel containing the medusæ depends upon the quantity of sea-water in that vessel; it is better to add too much than too little. About 10 cc. of formalin may be taken as about the mean quantity to add to 100 cc. of sea-water.

The secret of success depends upon keeping the medusæ in motion whilst the formalin is being poured in. First stir the medusæ very slowly and very gently round and round with a clean glass rod. When all are in motion then begin pouring in the formalin slowly and gently down the side of the vessel. Keep the medusæ in motion whilst the formalin is being added, and for at least two minutes after. The stirring is very important, as it produces an even distribution of the formalin in the sea-water, and the motion keeps the medusæ off the bottom and allows them to die in a fairly good expanded condition.

The medusæ may be left at the bottom of the vessel for a few hours, and then they must be transferred to a stronger solution of formalin. I store my specimens in a 10 per cent. solution of formalin, and change it at least once before finally sealing the bottle. Another method is to pour a small quantity of 20 per cent. formalin, or even a few drops of formaldehyde, into the bottle before finally storing it away. I firmly believe in using plenty of formalin, as I have often found medusæ in a state of maceration when only very weak solutions have been used.

The method of simply adding formalin to the sea-water and giving a gentle stir round is the quickest and easiest method for killing medusæ. It gives fairly good results with all kinds of medusæ, but some species are more liable to contract than others. The results are usually better when the medusæ are in a fairly quiescent condition than when they are vigorously swimming about.

Cocaine and Formalin.—To obtain medusæ in a nice state of expansion and with the tentacles stretched out it is necessary to use an anæsthetic. This gives a little extra trouble, but the results are well worth the trouble when really nice specimens are wanted. The anæsthetic which I use is hydrochlorate of cocaine (soluble in water), in a 1 per cent. or 2 per cent. solution, either in fresh water or in sea-water. As only a very small quantity is used at one time, a bottle containing 100 cc. lasts a long time. It is best to place the medusæ in a glass vessel with just sufficient sea-water for them to swim in. Add a little cocaine (about 3 cc. of 1 per cent. cocaine for every 100 cc. of sea-water) and stir gently with a glass rod to mix the cocaine with the sea-water. If the medusæ at the end of about 10 to 15 minutes have their tentacles expanded and they do not contract when touched with the glass rod no more cocaine need be added; but if still active, add a little more cocaine and repeat the stirring process. It is better to add about half the cocaine at first, and gradually increase the quantity, than to give the whole dose at once. An overdose usually causes a prolonged contraction. When the medusæ are anæsthetized stir them gently round and pour in the formalin solution. Keep on stirring whilst the formalin is being added, and for a minute or longer after.

Specimens must not be left long in any solution containing cocaine, as it has a softening action, causing the umbrella to lose its firmness and to become very limp.

When only one or two specimens have to be preserved a large watch-glass or a small glass pot had better be used. Place in it the specimen with just sufficient sea-water to cover, add two or three drops of cocaine. As soon as it is anæsthetized pour the formalin or the fixing reagent quickly upon the specimen.

Formalin and Chromic Acid for Scyphomedusæ.—Small Scyphomedusæ die fairly well expanded when simply placed in formalin 10 per cent. in sea-water. The addition, after the medusa is dead, of chromic acid is a distinct advantage. The chromic acid acts upon the jelly and makes it tougher and more pliable. The yellowish-brown colour of the chromic acid may be disregarded, as it gradually turns to a pale bluish-green by oxidation. The strength of the chromic acid may be either 5 or 10 per cent., the exact percentage is of little importance; just pour in enough to colour the formalin. The mixture I use contains roughly about one volume of chromic acid 5 per cent. solution, and nine volumes of formalin 10 per cent. solution.

After the specimen has been soaking several days in the chromic-formalin solution, into which a little strong formaldehyde must be daily poured and well stirred up, it should be transferred, without washing, to a fresh 10 per cent. solution of formalin, and then the bottle may be sealed and stored away. If, however, a few months later it should be noticed that the formalin is becoming cloudy and milky, it means that maceration is going on, and that an insufficient quantity of formalin was used. The bottle should at once be opened, the fluid poured off, and a fresh solution of formalin added.

The successful preservation of Scyphomedusæ, especially the large ones, greatly depends upon using plenty of strong formalin, so that the animal may become thoroughly saturated. It must be remembered that a jelly-fish contains an enormous quantity of fluid, all of which has to be replaced by the formalin solution. Hence the necessity of keeping up the strength of the solution and the stirring.

Damage done by Air-Bubbles in Tubes and Bottles.—Although great care is sometimes taken in preserving medusæ, yet no care is taken in properly storing the specimens for travelling. I have frequently opened tubes and bottles containing specimens in an excellent state of preservation, but broken in fragments. The damage has been done after the specimens went into the bottle, and not by the tow-net. There is nothing more disastrous to delicate animals, like medusæ, than an air-bubble rolling about in a narrow tube, or a large air-space in a bottle which is subject to the rolling of a ship or the shaking in a railway-train. Bottles with large hollow glass-stoppers are frequently responsible for the destruction of specimens; such stoppers should be plugged-up with paraffin-wax. If tubes are being used a plug of cotton-wool should be placed in. After the specimens are in the tube, fill it to the brim with formalin, and then push in a tight-fitting plug of cotton-wool, which has been previously saturated with formalin, taking care not to introduce an air-bubble. The tubes can either be stored in a large jar of formalin, or corked and sealed with paraffin-wax.

When bottles are used, the common 1 oz. to 4 oz. sizes, with the best corks, are most

suitable for small medusæ; I prefer them for travelling purposes to glass-stoppered bottles. The formalin does not dissolve out the tannin from the cork, as alcohol does. It is a mistake to pack small specimens in cotton-wool, they only get crushed by the weight of the wool. Simply fill the bottle to the brim with formalin, and gently hammer in the cork with a light wooden mallet. With a little care a large air-bubble can be avoided, and a tiny one is fairly harmless, provided that it cannot touch the specimen. As a precaution against leakage and evaporation it is advisable to seal the cork, when it has become quite dry, with hard paraffin-wax.

HYDROMEDUSÆ.

Order ANTHOMEDUSÆ.

Fam. Margelidæ.

Margelis autumnalis (Hartlaub), 1897.

Bougainvillea autumnalis, Hartlaub, 1897, p. 465, Taf. 15.

An adult specimen. Umbrella about 2·5 mm. in diameter. Gonads large. About six to seven tentacles on each of the four perradial bulbs.

Occurrence: 25 to 0 fathoms. 33 *g* (1 specimen).

Distribution.—North Sea; English Channel; west coast of Ireland.

This species belongs to the neritic fauna; its hydroid is at present unknown.

Order LEPTOMEDUSÆ.

Fam. Eucopidæ.

Obelia lucifera (Forbes), 1848.

Thaumantias lucifera, Forbes, 1848, p. 52, pl. 10.

Six specimens, none of which have ripe gonads.

Occurrences: Surface, 21 *e* (1 specimen); 23 *b* (2), 23 *d* (1), 24 *g* (1). 100 to 0 fathoms, 25 *d* (1).

This species belongs to the neritic fauna. It is at present uncertain to which hydroid species *Obelia lucifera* belongs.

Tima sp. ?

Description.—The umbrella is thick, moderately curved, and more than twice as broad as high. The velum is narrow. The stomach is very small and flat; it is situated upon a broad, short, somewhat cone-shaped peduncle. The mouth is small and has a folded margin. Four narrow radial canals. The gonads are immature, and are situated upon the radial canals, probably extending along nearly their whole length. About

24 tentacles, with long, narrow, tapering basal bulbs. About 5 or 6 marginal bulbs between every two tentacles. One or two cirri between every two bulbs. One sensory vesicle between every two bulbs.

Size: Umbrella 25 mm. in width and 10 mm. in height.

Occurrence: 50 to 0 fathoms. 36 *d* (1 specimen).

The specimen is rather macerated. I believe, from the appearance of the gonads, that the medusa has only reached an intermediate stage of development.

Order HYDROIDA.

Fam. Campanulariidæ.

Campanularia flexuosa, Hincks, 1868.

Campanularia flexuosa, Hincks, 1868, p. 168, pl. 33.

A few small pieces of this hydroid were taken in the surface tow-nets. The pieces are from the upper part of a colony, and look as if they have only just been broken off. The hydranths are well expanded, and a few gonothecæ are present.

Campanularia flexuosa is a fixed hydroid and belongs to the littoral fauna. Its occurrence so far from its usual habitat is probably due to seaweed drifting away from the coast.

Occurrences: Surface. 24 *f*, 24 *g*.

Order TRACHOMEDUSÆ.

Fam. Trachynemidæ.

Trachynema eurygaster (Gegenbaur), 1856.

Sminthea eurygaster, Gegenbaur, 1856, p. 245, Taf. 9.
Marmanema mammæforme, Haeckel, 1879, p. 262, Taf. 17.
Sminthea eurygaster, Metschnikoff, 1886, p. 244, Taf. 1.
Trachynema eurygaster, Maas, 1893, p. 12.

There are ten specimens, of which three are in fair condition. They resemble very closely the figures given by Gegenbaur and Haeckel.

The umbrella of the largest specimen measured 4·5 mm. in width and 2 mm. in height. The velum is about 1 mm. in width. There are eight tentacles (all the specimens have the tentacles broken off near to the base), one opposite each of the eight radial canals. The gonads are very small, globular in shape, and are situated quite close to the margin of the umbrella, one on each radial canal.

Occurrences: 100 to 0 fathoms. 35 *d* (1 specimen), 36 *e* (2).
150 to 0 fathoms. 36 *f* (4).
250 to 0 fathoms. 36 *h* (2), 36 *i* (1).

Distribution.—Messina; Canary Is.; off the north coast of Brazil in South Equatorial stream.

This is a rather rare species. It was taken only once by the 'National' Plankton Expedition.

Colobonema sericeum, Vanhöffen, 1902, p. 56, Taf. 9, 12.

There is one specimen. The umbrella, owing to the firmness of the jelly, has retained its shape very well, but the preservation is by no means good.

The umbrella is highly curved, about 18 mm. in height and in width; the velum is broad, about 4 mm. The stomach is very short; it is contracted, and forms simply a narrow ring about 2 mm. in diameter. Eight radial canals. There are indications of gonads extending along the radial canals, as figured by Vanhöffen, but the canals are in a macerated condition, and nearly all the circular muscles on the sub-umbrella have disappeared. There are 32 tentacles, all of which are broken off close to the base. The per-canal (opposite the radial canals) and ad-canal tentacles are very much larger than the inter-canal tentacles; the latter are just beginning to develop. The root of a tentacle resembles Vanhöffen's figure (Taf. 12. fig. 42). Sense-organs were searched for, but were not found.

Occurrence: 250 to 0 fathoms. 36 *h* (1 specimen).

Distribution.—This species is one of the new deep-sea medusæ discovered by the 'Valdivia.' It was found off the west coast of Africa from the Gulf of Guinea to the south of Cape of Good Hope (lat. 42° S.), and also widely distributed over the Indian Ocean. It was taken in open vertical nets worked from the depth of about 1600 to 650 fms., once in a closing-net working between 820 to 500 fms., and once in a trawl at about 350 fms. Its occurrence in the Bay of Biscay considerably extends the area of its distribution.

I have associated the Biscayan specimen with Vanhöffen's species because the latter was also found in the Atlantic. Maas, however, has described a *Colobonema* (*C. typicum* ?) found by the 'Siboga' Expedition in the East Indies (Straits of Makassar; off Timor, Ceram, and other islands), and taken at a depth of about 1350 to 230 fms. He suggests that it is probably identical with *Colobonema sericeum* and with *Homœonema typicum*, Maas, 1897. This latter species was found in the Pacific, off Costa Rica, and in the Gulf of California. I think that the specimens of *Colobonema* collected on the 'Valdivia' and 'Siboga' Expeditions probably belong to the same species, but am rather doubtful about their connection with *Homœonema typicum*.

Rhopalonema cœruleum, Haeckel, 1879, p. 264, Taf. 17. figs. 3–6.

There are about seventy specimens, but out of these only about a dozen are in fairly good condition. Many have the margin of the umbrella in such a bad state that the tentacles, cirri, and sense-organs have completely disappeared.

Description based upon the largest Specimens.—The umbrella is fairly highly curved, with a small somewhat conical top-knot. There is a slight variation in the shape of the umbrella and in the shape of the top-knot. The figure by Haeckel (Taf. 17. fig. 3) gives a fairly good idea of the shape of the umbrella, but most of the Biscayan specimens have a slightly more rounded umbrella. The umbrella is broader than high. Among the larger specimens the height remains fairly constant, about 6 to 7 mm. The width is variable, 7 to 10 mm. The ex-umbrella is marked with radial furrows, which may be

due to shrinkage. The velum is very broad, about 2 to 2·5 mm. in width. The stomach is cylindrical in shape when stretched out, and is about half the length of the umbrella-cavity. The mouth has four small lips. The gonads are upon the eight radial canals, and occupy, as a rule, the central third portion of the canals, but they vary slightly in position, being in some specimens a little nearer the stomach, in others a little nearer the margin of the umbrella. The gonads are at first linear, but when mature they become cylindrical. Their length is variable, about 1 to 3 mm. There are eight per-canal tentacles, 8 inter-canal cirri, and 16 ad-canal cirri; 16 sense-organs (two in each octant, one next the inter-canal cirrus and one next the per-canal tentacle), but perhaps more.

Size: Umbrella up to 10 mm. in width and 7 mm. in height. (Most of the specimens about 6 to 8 mm. in width.)

Early Stages: There are a few early stages. One of these measures 2 mm. in diameter. It has 8 per-canal tentacles, 8 inter-canal cirri, and a sense-organ next to the inter-canal cirrus. No gonads visible.

Sense-organs.—The search for sense-organs with a moderate high-power lens has not yielded very definite results. When sense-organs could be found I usually saw the one next to the inter-canal cirrus. In three specimens I clearly saw a sense-organ next to the per-canal tentacle, and a few other specimens also showed a cell which somewhat resembled a sense-organ in a similar position. In one specimen, and in one octant only, I saw three sense-organs; as it only occurred once, it may be an instance of numerical variation. It may, however, be simply normal development, in which case the species would probably have four sense-organs in each octant. The sense-organ next the inter-canal cirrus appears, from its size and frequency in the specimens, to develop first, and then next in order comes the one near the per-canal tentacle. The latter is usually very small in size and very hard to see.

Occurrences:	Surface.	23 *b* (1 specimen).
	25 to 0 fathoms.	30 *b* (3), 31 *a* (1).
	50 to 0 fathoms.	21 *g* (1), 25 *g* (1), 25 *k* (5), 26 *c* (2), 30 *d* (1), 30 *l* (3), 31 *b* (4), 36 *d* (1).
	75 to 0 fathoms.	32 *m* (2), 35 *a* (1), 35 *c* (1), 36 *a* (1).
	100 to 0 fathoms.	24 *b* (5), 24 *d* (4), 24 *e* (2), 25 *d* (2), 30 *h* (1), 32 *d* (4), 32 *i* (2), 32 *n'* (1), 32 *p* (4), 33 *d* (4), 34 *b* (1), 34 *d* (2), 35 *b* (2), 35 *d* (4), 35 *x* (2), 36 *b* (2).
	200 to 0 fathoms.	36 *g* (1).
	250 to 5 fathoms.	36 *h* (1).
	350 to 0 fathoms.	36 *l* (1).

This species was evidently occupying a zone between 50 and 100 fathoms, and there is no proof that it occurred at a greater depth.

Distribution.—Canary Islands.

The identification of the species belonging to the genus *Rhopalonema* appears to me to be becoming rather difficult. I do not think that I shall be going far astray in assigning

the name *Rhopalonema cæruleum* to the Biscayan specimens, for they come nearer to this species as described and figured by Haeckel than to any other species.

Maas (1905) has described and figured a *Rhopalonema* which was taken in deep water (500 to 1350 fms.) by the 'Siboga' Expedition in the East Indies, under the name of *Rhopalonema cæruleum*, and also states that it is identical with *Rhopalonema funerarium* described by Vanhöffen from the 'Valdivia' collection. The figures given by Vanhöffen and by Maas do not show the top-knot on the umbrella, which is always present in my specimens. Their figures also show longer gonads, which come near the margin of the umbrella. They find four sense-organs in each octant. Their specimens are of larger dimensions than those from the Bay of Biscay.

Homœonema platygonon, Maas, 1893.

Homœonema platygonon, Maas, 1893, p. 15, Taf. 1; Browne, 1903, p. 21, pl. 2.

There are four specimens; one of them I identified as *Homœonema platygonon*, but about the other three I was uncertain. They appeared to me to belong to this species, but showed characters of the genus *Haliscera*. Under these circumstances I considered it advisable to consult Prof. Maas and let him see the specimens; he informed me by letter that all the specimens belonged to one species, namely, *Homœonema platygonon*. As Prof. Maas intends revising the species of the genera *Homœonema* and *Haliscera*, I am glad that these specimens were sent to him.

Notes on the specimens:—

(*a*) This specimen resembles very closely that shown in Maas's figure, but it is at an earlier stage of development. The umbrella is hemispherical, nearly 2 mm. in width and 1 mm. in height. The velum is about 0·5 mm. in width. The stomach is circular, about 0·75 mm. in diameter. There are seven radial canals, instead of eight, which is the normal number. The gonads are just beginning to appear upon the radial canals, adjacent to the stomach. About 5 to 6 tentacle-stumps in each octant. Four sense-organs.

(*b*) This specimen is not in very good condition. The umbrella is about 3 mm. in height; it has a conspicuous cone-shaped mass of jelly, which is quite half the length of the umbrella, above the flat top of the stomach. The cells of the radial canals are in a macerated condition, and I cannot distinguish the generative cells with certainty. The gonads may be regarded as quite immature.

(*c*) The umbrella is a little broader than high, with a rounded summit, and moderately thick. The velum is very broad, exceeding 1 mm. in width. The stomach is circular, 2 mm. in diameter, with a flat top. The mouth is circular, and is expanded nearly to the periphery of the stomach. Eight radial canals. The gonads are upon the radial canals, adjacent to the stomach. In this specimen, which is a female, each ovary is a semicircular swelling containing a few large ova. From five of the radial canals the gonads have disappeared, and from the appearance of the canals the ova have evidently been shed. About 10 to 12

tentacle-stumps in each octant. Eight sense-organs, one in each octant; they are external, fairly large, and have a short stalk.

Size: Umbrella about 3 mm. in width and 2·5 mm. in height.

(*d*) This specimen is in rather bad condition. It is about the same size and probably about the same shape as specimen *c*. It shows the lower wall of the stomach in an expanded condition, and also shows that the mouth is capable of closing. I presume the specimen to be a male with unripe gonads, which are situated upon the radial canals quite close to the stomach. The radial canals in the proximity of the gonads are sac-like, and upon the outer wall of the sac a gonad is situated as a semi-globular swelling. Two sense-organs were found in one octant.

Occurrences: 100 to 0 fathoms. 24 *e* (1 specimen).
200 to 0 fathoms. 36 *g* (1).
250 to 0 fathoms. 36 *h* (1).
350 to 0 fathoms. 36 *l* (1).

Distribution.—Between Iceland and Greenland, lat. 60° N., 'National' Plankton Expedition; Norway, Skjerstadfjord, within the Arctic Circle, 230 to 0 fms. and 270 to 0 fms.; Byfjord, near Bergen, 55 to 110 fms.

Our knowledge of the distribution of this species is at present rather limited. It seems, however, to like rather cold water, and prefers to live below 100 fathoms.

Aglantha rosea (Forbes), 1848.

Circe rosea, Forbes, 1848, p. 34, pl. 1.
Aglantha rosea, Browne, 1898, p. 833, pl. 49; 1903, p. 23.

This species is one of the commonest forms in the collection. There are nearly 200 specimens; about half of them are in fair condition, but only a very few are perfect.

The smallest specimens are a little less than one millimetre in length and are quite early stages. Most of the specimens are about 5 to 7 mm. in length, and a few are larger. The umbrella of the largest specimen measured 11 mm. in length and 5 mm. in width. A specimen 10 mm. in length and 5 mm. in width has about 72 tentacles, and one measuring 6 mm. in length and 3·5 in width has about 64 tentacles.

In the search for sense-organs I found a few specimens which possessed sense-organs in adjacent octants, and also had the satisfaction of counting eight sense-organs in one of the largest specimens. This established beyond doubt the identification of the species. It is only in the most perfect specimens and in those with the margin of the umbrella nicely expanded that more than half the sense-organs are likely to be seen. The sense-organs, like the tentacles, are usually broken off in the tow-net, and even when present their minuteness renders them hard to find if the margin of the umbrella is curled inwards.

Some of the larger specimens have gonads about 1 mm. in length, and many of the smaller specimens (about 5 to 7 mm. in length) show the gonads forming on the radial canals at the base of the peduncle of the stomach.

Occurrences:	Surface.	22 *d* (1), 22 *e* (4), 23 *b* (9), 23 *d* (1).
	50 to 0 fathoms.	21 *g* (2), 30 *l* (18), 31 *b* (6), 32 *a* (1), 32 *h* (1), 33 *c* (1).
	75 to 0 fathoms.	30 *f* (5), 32 *g* (2), 35 *c* (1).
	100 to 0 fathoms.	21 *h* (26), 21 *l* (20), 22 *a* (32), 24 *b* (2), 24 *d* (16), 24 *e* (4), 25 *d* (5), 30 *g* (2), 30 *h* (1), 32 *n'* (1), 32 *p* (1), 33 *d* (2), 34 *d* (1), 35 *b* (1), 35 *f* (1), 36 *b* (1), 36 *e* (2).
	150 to 0 fathoms.	36 *f* (1).
	150 to 50 fathoms.	21 *p* (7).
	200 to 0 fathoms.	36 *g* (1).
	200 to 100 fathoms.	21 *o* (4), 35 *m* (1).
	250 to 0 fathoms.	36 *i* (1).
	300 to 200 fathoms.	21 *c* (1).
	500 to 400 fathoms.	21 *m* (2).
	750 to 500 fathoms.	22 *b* (1).
	1000 to 750 fathoms.	23 *a* (1).
	1250 to 1000 fathoms.	24 *a* (1).

It appears from the number of hauls in which *Aglantha* occurs that it was chiefly inhabiting the lower part of a zone between 50 and 100 fathoms. It was scarce at or near the surface, and also at depths below 100 fathoms.

Distribution.—Norway; Shetland Is.; North Sea; Færoe Channel; west coast of Ireland; mouth of the English Channel.

AGLANTHA sp. B.

There are six specimens of an *Aglantha* which I have isolated on account of the radial canals being twice the width of the canals of *Aglantha rosea*, and also because the umbrella is about as broad as long. These specimens are without gonads, and the sense-organs could not be found. I think that they must be young stages of another species, perhaps *Aglantha digitalis*. The largest specimen measured 7 mm. in length and width.

Occurrences:	750 to 500 fathoms.	22 *b*.
	1000 to 750 fathoms.	23 *a*.
	1250 to 0 fathoms.	27 *a* (trawl).
	1500 to 750 fathoms.	30 *a* (trawl).

AGLAURA HEMISTOMA, Péron et Lesueur, 1809.

Aglaura hemistoma, Haeckel, 1879, p. 275, Taf. 16; Maas, 1893, p. 25, Taf. 1; Mayer, 1900, p. 65, pl. 25; Vanhöffen, 1902, p. 78; Mayer, 1904, p. 26, pl. 4; Lo Bianco, 1904, p. 55, fig. 138.

The collection contains about 130 specimens, a few of which are in good condition. The umbrella of the largest specimen measured about 3 to 3·5 mm. in height and about

2 mm. in width. The shape of the umbrella is similar to that in the specimens figured by Maas. The peduncle of the stomach is very short, about one-sixth the length of the umbrella. The gonads are upon the peduncle, just above the stomach. At first the gonads are little oval or globular swellings, and as they increase in size they become cylindrical and hang down. A specimen 3 mm. in height had cylindrical gonads about 1·25 mm. long and 64 tentacles. Only one specimen was seen with tentacles, and it had a nearly complete set in a closely contracted state; all the others had only the roots or stumps of the tentacles remaining.

Occurrences: Surface.	21 *i* (1), 23 *b* (1), 32 *c* (2), 33 *a* (3).
25 to 0 fathoms.	30 *b* (4), 30 *m* (24), 31 *a* (12), 32 *b* (1), 34 *g* (2), 35 *w* (3).
50 to 0 fathoms.	30 *d* (12), 30 *l* (3).
75 to 0 fathoms.	30 *f* (13), 32 *g* (1), 32 *o* (2), 35 *a* (2), 35 *c* (5), 35 *y* (3).
100 to 0 fathoms.	21 *h* (1), 30 *g* (14), 30 *h* (16), 34 *d* (1), 35 *f* (2), 35 *x* (1).

It was occupying a zone extending from the surface down to 100 fathoms.

Distribution.—The tropical and subtropical waters of the North Atlantic and Indian Oceans.

Aglaura hemistoma is widely distributed over the warm-water area of the North Atlantic, and it also occurs in the Mediterranean. The 'National' Plankton Expedition did not find it north of latitude 45° N.

Order NARCOMEDUSÆ.

Fam. Cunanthidæ.

Cunoctantha fowleri, nova species. (Pl. 13. figs. 1 & 2.)

Description of Species.—The umbrella is watchglass-shaped, about three times as broad as high. The stomach is circular, with eight lateral pouches extending to the margin of the umbrella. Upon the pouches of the stomach there are medusa-buds, which are not parasitic. Eight rather long tentacles. Five sense-organs upon each of the eight marginal lobes.

Size: Umbrella about 4 mm. in diameter.

Occurrence: 50 to 0 fathoms. 31 *b* (1 specimen).

There is only one specimen, which is in fairly good condition. The umbrella is slightly crumpled and its margin is curled inwards. The velum has broken away and only slight traces of it remain. The mouth is expanded and circular in shape. The pouches of the stomach are broadest in the middle and become narrower as they approach the margin of the umbrella. Upon the pouches of the stomach there are one to three medusa-buds showing various stages of development. There are no gonads present, but they should appear at a later stage, after the gemmation-period is over. The length of the tentacles is about equal to the diameter of the umbrella, and they taper out to a fairly fine point. The peronial groove is broad and shallow, and contains a band (the peronium) of nematocysts, which broadens out at the bases of the tentacles. The lobes

of the umbrella are slightly rounded, but their shape is not very well seen owing to the curling inwards of the margin. Some of the sense-organs are broken off, but many remain. Their number, however, is ascertainable by the narrow rows (the otoporpæ) of nematocysts which extend a little way up the ex-umbrella side of the marginal lobe. Each otoporpa is in continuity with a minute bulb containing nematocysts on the margin of the umbrella, and upon every bulb a sense-organ is situated.

Development of the Medusa-buds.—The medusa-buds form a nearly complete series which shows very well the course of their development. They resemble in external appearance the figures given by Maas (1892) and by Chun (1894) for the development of a *Cunina*-bud.

Two adjacent pouches of the stomach were removed and cut into sections. The sections show that a bud begins as a hollow outgrowth of the wall of the pouch (fig. 2, B^1, B^2). Sections were also cut of a later stage; its shape and structure agree with the figures given by Maas (1892, fig. 23) and by Chun (1894, fig. 64, *v.*). It is evident from these sections that the buds are developing directly from the wall of the pouch and that they are not of a parasitic origin.

The largest and most advanced medusa-bud shows the outgrowth of the eight tentacles, the velum, the eight marginal lobes, and two sense-organs upon each lobe. This medusa-bud was removed from the pouch for examination, and an opening (fig. 1, *O.*) into the cavity of the pouch was found.

So far as I know, no species of *Cunoctantha* or *Cunina* have hitherto been described with medusa-buds developing directly from the wall of the stomach or its pouches. Brooks (1886), in his account of the life-history of the Narcomedusæ, says: "No one has shown, by careful examination, that any adult *Cunina* produces buds from its stomach or from any other part of its body, and there is every reason for believing that the *Cunina* larvæ found in their stomachs are parasites, like those found in *Turritopsis* and in Geryonids, and that the *Cunina* larva found in the stomach of an adult *Cunina* does not necessarily belong to the same species with the adult."

A medusa bearing medusa-buds is usually at an early or intermediate stage of development, and does not show all the characters found in the fully grown adult with gonads. *Cunoctantha fowleri* has yet to be connected with an adult medusa bearing gonads. At its present stage it has eight tentacles, which admits it to the genus *Cunoctantha*; but in the adult stage it may have more than eight tentacles, in which case it would belong to the genus *Cunina*.

Pegantha sp.

There are two specimens which are not in good condition. They look like young stages of a *Pegantha*, and are without gonads.

(*a*) Umbrella about 7 mm. in width and 5 mm. in height; 13 tentacles alternating with 13 marginal lobes. About three sense-organs on each lobe.

(*b*) Eleven tentacles and eleven lobes. About five sense-organs on each lobe.

Occurrences: 200 to 0 fathoms. 36 *g* (1).
350 to 0 fathoms. 36 *l* (1).

Solmundella sp.

The collection contains two early stages, which are in rather bad condition.

Occurrences: 75 to 0 fathoms. 34 *c* (1).
100 to 0 fathoms. 22 *a* (1).

Order SCYPHOMEDUSÆ.

Periphylla sp.

Two quite early stages, the larger measuring about 7 mm. in diameter. The specimens are not in good condition, but the margin of the umbrella is sufficiently complete for the identification of the genus.

Occurrences: 350 to 0 fathoms. 36 *l* (1).
400 to 300 fathoms. 21 *k* (1).

Distribution.—Periphylla is one of the genera belonging to the group of deep-sea medusæ, and its species have a very wide geographical range. The Biscayan specimens are probably early stages of *Periphylla hyacinthina*, Steenstrup, which occurs on the European side of the Atlantic.

Atolla bairdii, Fewkes, 1886.

Atolla bairdii, Fewkes, 1886, p. 936, pls. 1–3; Vanhöffen, 1892, p. 16, Taf. 4; Vanhöffen, 1902, p. 9; Maas, 1904, p. 49, pls. 4–5.

The collection contains one specimen, which has the margin of the umbrella in fairly good condition, but the gonads, stomach, and mouth are mutilated.

The umbrella is about 40 mm. in diameter. Upon the central disc of the umbrella there are radial furrows which are visible when the specimen is lifted out of formalin. The presence of radial furrows is one of the characters for distinguishing *Atolla verrillii* from *Atolla bairdii*; but as Maas has found indications of furrows on the central disc of *Atolla bairdii*, I think that I shall not go far wrong in regarding the specimen as *Atolla bairdii*. There are 21 tentacles and 21 sense-organs. The shape of the pedalia and the marginal lobes resemble the figures by Maas of *Atolla bairdii*.

Occurrence: 1500 to 750 fathoms. 30 *a* (1).

Distribution.—Atolla bairdii occurs on the western side of the North Atlantic, off the coast of North America; and on the eastern side from the Bay of Biscay nearly to the Equator. It is a deep-sea medusa, and has been usually taken below 500 fathoms and below the temperature of 50° F.

Pelagia? *Ephyra* stage.

Three specimens of very early *Ephyra* stages, which I am not able to identify with certainty.

Occurrences: Surface. 21 *i*, 23 *e*.
25 to 0 fathoms. 30 *m*.

Medusæ occurred in the following hauls, but the genera could not be recognized owing to the bad condition of the specimens.

LEPTOMEDUSÆ.

fathoms.	
200–0	36 *g* (1).
350–0	36 *l* (1).

TRACHOMEDUSÆ.

50–0	36 *d* (1).
75–0	35 *a* (1).
100–0	35 *x* (1), 36 *b* (1).
200–0	36 *g* (2).
250–0	36 *h* (5), 36 *i* (5).
300–0	36 *k* (3).
350–0	36 *l* (1).

NARCOMEDUSÆ.

100–0	33 *d* (1).
250–0	36 *i* (1).
500–250	29 *a* (1) (trawl).
1000–750	31 *d* (1).
2000–1000	30 *e* (1) (trawl).

EXPLANATION OF PLATE 13.

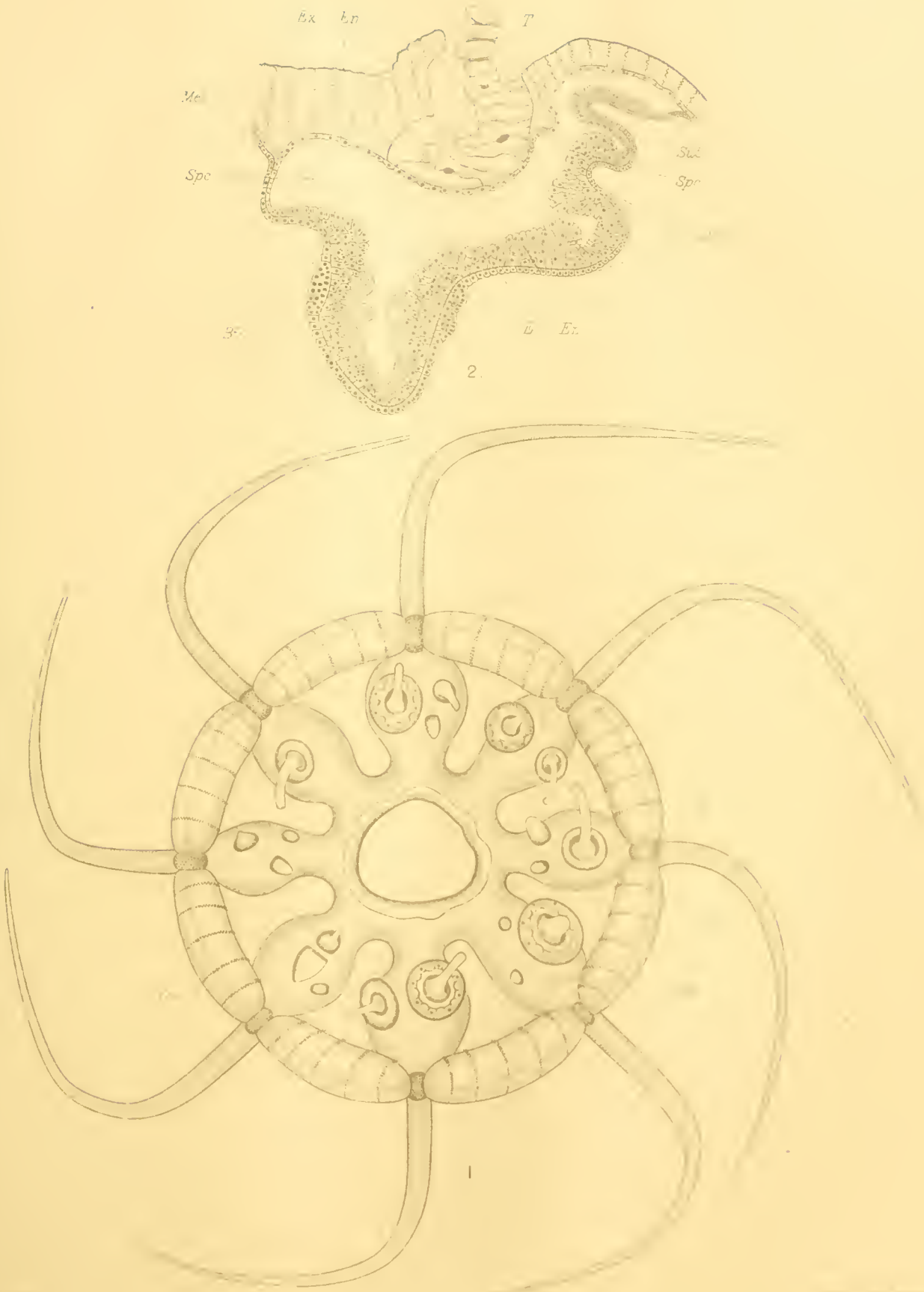
Reference letters.

B. Medusa-bud.
Ec. Ectoderm.
En. Endoderm.
Ex. Ex-umbrella.
Mes. Mesoglœa.
O. Opening into stomach-pouch where a medusa-bud has been removed.
Ot. Otoporpa.
P. Peronium.
Sp. Stomach-pouch.
Spc. Cavity of stomach-pouch.
Sub. Sub-umbrella.
T. Base of tentacle.

Cunoctantha fowleri, sp. n.

Fig. 1. Oral side of the medusa drawn to show the pouches of the stomach with medusa-buds in various stages of development. Semi-diagrammatic. ×20.

Fig. 2. Transverse section of a pouch of the stomach (drawn with the aid of a camera lucida), showing two very early medusa-beds. The bud B^1 is just beginning to develop, and bud B^2 is at a little later stage. ×120.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NOTE ON THE DISTRIBUTION OF THE MEDUSÆ.

By G. Herbert Fowler, *F.L.S.*

All specimens of Medusæ, however greatly damaged *, were as far as possible picked out from the various hauls and submitted to Mr. Browne. Three species occurred with sufficient regularity to allow of their being dealt with statistically † in the manner attempted for some other groups in these Reports.

Rhopalonema cœruleum, Haeckel.

‡ In hauls with open nets at	fathoms, this species occurred in	haul, with	per cent. of the hauls, with	average specimens per hour haul.
0	6			0·04
25	16			0·33
50	61			1·30
75	36			0·50
100	72			2·00
150	0			0·00
200	1			0·25
250	1			0·25
300	0			0·00
350	1			0·50

It was not taken in any closing-net, and may fairly be set down as a purely epiplankton species, with a maximum distribution at about 50–100 fathoms. Nowhere plentiful, it was least so at the surface, of all the five epiplankton zones investigated.

Aglantha rosea (Forbes).

In hauls with open nets at	fathoms, this species occurred in	haul, with	per cent. of the hauls, with	average specimens per hour haul.
0	25			0·9
25	0			0·0
50	46			2·3
75	27			0·8
100	77			5·7
150	0			0·0
200	1			0·25
250	1			0·25
300	0			0·0
350	0			0·0

* Incidentally it is worth noting that of 27 specimens so damaged as to be generically unrecognizable, 19 (70 per cent.) occurred in the five serial hauls 36 *g* to *l*—a fact to be considered by those who advocate "the differential method of serial tow-nets" for the study of mesoplankton.

† In the following tables the usual time-factor has been employed (p. 60, note); the 9 hauls with a net of 180 meshes per linear inch have been included, as having caught medusæ, and averages have been struck over all hauls at the depth mentioned, not merely over those in which the species occurred.

‡ These tables are to be read as a sentence from left to right.

It is obvious that of the five epiplankton zones studied, this species was most plentiful in number and most frequently captured at 100 fathoms.

Unlike the previous species, it also occurred in eight closing-nets. This number is not large, out of a total of 37 such nets, but sufficiently large to suggest that the species was really alive at some considerable depth, and that the captures, at any rate in the upper mesoplankton, were not merely of dead specimens sinking to the bottom; in the lower zones they may have been so, as this was the commonest epiplankton species.

The following table shows a sudden drop below 500–400 fathoms in the average number of specimens captured per 100 fathoms traversed:—

Between	fathoms, there occurred	* specimens in	hauls, out of	total hauls, with	average specimens per 100 fathoms.
150–50	7	1	1		7·00
200–100	5	2	7		0·71
300–200	1	1	3		0·33
500–400	2	1	3		0·66
750–500	1	1	4		0·10
1000–750	1	1	5		0·08
1250–1000	1	1	3		0·13

This drop may indicate approximately the break between living and dead specimens; and in this connection it is interesting to compare the observations on the same species in the Færoe Channel (Proc. Zool. Soc. 1898, p. 1023). I have also added a similar comparison of the distribution of *Aglantha digitalis* in the Færoe Channel with the six specimens from the Bay of Biscay which Mr. Browne thinks may perhaps be referable to this species (p. 176 above).

Locality.	*rosea.*			*digitalis.*		
	Captures.	Fathoms.	Temp. ° F.	Captures.	Fathoms.	Temp. ° F.
Færoe Channel.	Highest	0	54	Highest	200–100	39–46
	Lowest	100–0	48–54	Lowest	500–400	30–31
Bay of Biscay.	Highest	0	63			
	Four Lowest	500–400	49–50			
		750–500	46–49	All ..	750–500	46–49
		1000–750	40–46		1000–750	40–46
		1250–1000	38–40		1500–750	37–46

It may be only a coincidence that *rosea* failed below a temperature of 46°–48° in the Færoe Channel, and that below 49°–50° the average specimens per 100 fathoms

* Actual numbers captured.

traversed drop to about 0·1 in the Bay of Biscay. If so, it is all the more curious, since *digitalis* failed at temperatures above 46° in the Færoe Channel, and the supposed *digitalis* above 46°–49° in the Bay of Biscay. While fully recognizing that these may be only double coincidences, I incline to the idea that they really give us the approximate temperature-limits of these two species—the maximum for *digitalis*, a truly Arctic form described from Greenland; the minimum for *rosea*, a temperate and tropical form. Unfortunately, owing to Haeckel having united them, it is practically impossible to be certain to which of them the older records refer; otherwise we should have a reliable check on this question. But it is worth noting that in a collection of Medusæ from Norway and Spitzbergen, on which Mr. Browne reported for the Bergen Museum (References, p. 181 above, Browne, 1903), *Aglantha rosea* extended from Southern Norway up to just inside the Arctic Circle (Skjerstadfjord), while *Aglantha digitalis* appeared only from the Lofoten Islands. This fits in well with the previous suggestion, and points to the probability that *A. rosea* prefers warmer water than *digitalis*; although they may overlap at about their temperature-limits, the maximum of the one is probably fairly close to the minimum of the other, and neither is very far from 47° F. (8°·3 C.).

Aglaura hemistoma, Péron & Lesueur.

In hauls with open nets at	fathoms, it occurred in	per cent. of hauls, with	average spec. per hour haul.
0	18	0·4	
25	50	3·8	
50	15	1·4	
75	54	2·8	
100	27	1·6	

Several of the epiplanktonic species treated earlier in these Reports have shown a marked and puzzling predominance at 50 and 100 fathoms, but not 75; this, both in frequency and numbers, exhibits a similar predominance at 25 and 75, but not at 50. It was not taken in any closing-net, and was obviously purely epiplanktonic.

None of the above species occurred with such regularity at the surface as to enable any deduction to be made with regard to a vertical oscillation.

Taking the species together, and including indeterminable specimens:—

In hauls with open nets at	fathoms, medusæ occurred in	per cent. of hauls, with	average spec. per hour haul.
0	40	1·8	
25	58	4·3	
50	84	5·3	
75	81	4·3	
100	100	9·7	

Both in actual numbers and in frequency of occurrence, the Medusæ as a whole were most plentiful at about 50–100 fathoms, scarcest at the surface.

Atolla bairdii, Fewkes.

Out of the sixteen captures recorded for this species, fourteen were in deep water with open nets, and are therefore practically useless for the determination of either the depth or of the temperature-limits. One was taken at the surface, apparently just in the cold-water belt of the Eastern United States, one by the 'Princesse Alice' in 1905 with the Giesbrecht closing-net at about 928 fathoms, and somewhere about 42°·8 F. The capture in haul 30 *a* shows a temperature between 37° and 46° F. (2°·7 to 7°·7 C.).

The following table exhibits the distribution of the captures, by hauls and depths. The first three hauls were made with the closing "mesoplankton trawl."

Depth in fathoms.	Haul.	*Margelis annulatis.*	*Obelia lucifera.*	*Tima* sp.	*Trachynema eurygaster.*	*Colobonema sericeum.*	*Rhopalonema coeruleum.*	*Homœonema platygonon.*	*Aglantha rosea.*	*Aglantha* sp.	*Aglaura hemistoma.*	*Cunoctantha fowleri.*	*Pegantha* sp.	*Solmundella* sp.	*Periphylla* sp.	*Atolla bairdii.*	*Ephyra.*	Spp. indeterm.
500—250	29 *a*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
1500—750	30 *a*	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1		
2000—1000	30 *e*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
0	21 *e*	..	1															
	21 *f*																	
	21 *i*	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1	
	22 *d*	..	..	..	..	..	..	..	1									
	22 *e*	..	..	..	..	..	..	..	4									
	22 *g*																	
	23 *b*	..	2	..	..	..	1	..	9	..	1							
	23 *c*																	
	23 *d*	..	1	..	..	..	..	..	1									
	23 *e*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	
	24 *c*																	
	24 *f*																	
	24 *g*	..	1															
	24 *h*																	
	24 *i*																	
	24 *k*																	
	25 *a*																	
	25 *b*																	
	25 *h*																	
	25 *i*																	
	25 *l*																	
	30 *c*																	
	32 *c*	..	..	..	..	..	..	..	..	..	2							
	33 *a*	..	..	..	..	..	..	..	..	..	3							
	33 *b*																	
25—0	26 *a*																	
	30 *b*	..	..	..	..	..	3	..	..	..	4							
	30 *m*	..	..	..	..	..	..	..	..	..	24	..	..	..	..	..	1	
	31 *a*	..	..	..	..	..	1	..	..	..	12							
	32 *b*	..	..	..	..	..	..	..	..	..	1							
	32 *e*																	
	33 *e*																	
	33 *g*	1																
	34 *a*																	
	34 *g*	..	..	..	..	..	..	..	..	..	2							
	35 *w*	..	..	..	..	..	..	..	..	..	3							
	36 *c*																	
50—0	21 *g*	..	..	..	..	..	1	..	2									
	25 *e*																	
	25 *g*	..	..	..	..	..	1[1]											
	25 *k*	..	..	..	..	..	5											
	26 *c*	..	..	..	..	..	2											
	30 *d*	..	..	..	..	..	1	..	..	..	12							
	30 *l*	..	..	..	..	..	1	..	18	..	3							
	31 *b*	..	..	..	..	..	4	..	6	..	..	1						
	32 *a*	..	..	..	..	..	..	..	1									
	32 *h*	..	..	..	..	..	..	..	1									
	33 *c*	..	..	..	..	..	..	..	1									
	33 *f*																	
	36 *d*	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	1
75—0	30 *f*	..	..	..	..	..	..	..	5	..	13							
	32 *g*	..	..	..	..	..	..	..	2	..	1							
	32 *m*	..	..	..	..	..	2											
	32 *o*	..	..	..	..	..	..	..	..	..	2							
	33 *h*																	
	34 *c*	..	..	..	..	..	..	..	..	..	..	..	..	1				
	35 *a*	..	..	..	..	..	1	..	..	..	2	..	..	..	..	..	..	1
	35 *c*	..	..	..	..	..	1	..	1	..	5							
	35 *e*																	
	35 *y*	..	..	..	..	..	..	..	..	..	3							
	36 *a*	..	..	..	..	..	1											

Depth in fathoms.	Haul.	*Margelis autumnalis.*	*Obelia lucifera.*	*Tima* sp.	*Trachynema curygaster.*	*Colobonema sericeum.*	*Rhopalonema cœruleum.*	*Homœonema platygonon.*	*Aglantha rosea.*	*Aglantha* sp.	*Aglaura hemistoma.*	*Cunoctantha fowleri.*	*Pegantha* sp.	*Solmundella* sp.	*Periphylla* sp.	*Atolla bairdii.*	*Ephyræ.*	Spp. indeterm.
100—0	21 *h*	..	..	..	..	..	..	..	26	..	1							
	21 *l*	..	..	..	..	..	..	..	20									
	22 *a*	..	..	..	..	..	..	..	32	..	..	..	..	1				
	24 *b*	..	..	..	..	..	5	..	2									
	24 *d*	..	..	..	..	..	4	..	16									
	24 *e*	..	..	..	..	..	2	1	4									
	25 *d*	..	1	..	..	..	2	..	5									
	30 *g*	..	..	..	..	..	..	..	2	..	14							
	30 *h*	..	..	..	..	..	1	..	1	..	16							
	32 *d*	..	..	..	..	..	4											
	32 *i*	..	..	..	..	..	2											
	32 *n*	..	..	..	..	..	1	..	1									
	32 *p*	..	..	..	..	..	4	..	1									
	33 *d*	..	..	..	..	..	4	..	2	..	..	..	..	..	..	..	..	1
	34 *b*	..	..	..	..	..	1											
	34 *d*	..	..	..	..	..	2	..	1	..	1							
	35 *b*	..	..	..	..	..	2	..	1									
	35 *d*	..	..	..	1	..	4											
	35 *f*	..	..	..	..	..	..	..	1	..	2							
	35 *x*	..	..	..	..	..	2	.	..	..	1	..	..	..	..	..	..	1
	36 *b*	..	..	..	..	..	2	..	1	..	..	..	..	..	..	..	..	1
	36 *e*	..	..	..	2	..	..	..	2									
150—0	36 *f*	..	..	..	4	..	..	..	1									
150—50	21 *p*	..	..	..	..	..	..	..	7									
150—100	21 *n*																	
200—0	21 *a*																	
	36 *g*	..	..	..	..	..	1	1	1	..	..	..	1	..	..	..	..	3
200—100	21 *b*																	
	21 *o*	..	..	..	..	..	..	..	4									
	26 *e*																	
	34 *h*																	
	35 *m*	..	..	..	..	..	..	..	1									
	35 *n*																	
	35 *t*																	
250—0	36 *h*	..	..	..	2	1	1	1	..	..	..	..	..	..	..	..	..	5
	36 *i*	..	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	6
250—150	35 *o*																	
	35 *p*																	
	35 *s*																	
300—0	36 *k*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3
300—200	21 *c*	..	..	..	..	..	..	..	1									
	26 *f*																	
	35 *l*																	
350—0	36 *l*	..	..	..	..	..	1	1	..	..	..	..	1	..	1	..	..	2
400—300	21 *k*	..	..	..	..	..	..	..	..	..	..	..	..	..	1			
	32 *l*																	
	35 *k*																	
500—400	21 *m*	..	..	..	..	..	..	..	2									
	35 *h*																	
	35 *i*																	
750—500	22 *b*	..	..	..	..	..	..	..	1	1								
	30 *k*																	
	34 *e*																	
	34 *f*																	
1000—750	23 *a*	..	..	..	..	..	..	..	1	1								
	27 *c*																	
	31 *d*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	32 *f*																	
	32 *k*																	
1250—1000	24 *a*	..	..	..	..	..	..	..	1									
	27 *b*																	
	31 *e*																	
1500—1250	25 *f*																	
	30 *i*																	
2000—1500	25 *c*																	
	26 *b*																	

BISCAYAN PLANKTON.

Part X.—THE FISHES.

By E. W. L. Holt *and* L. W. Byrne.

(*Communicated by* Dr. G. Herbert Fowler, *F.L.S.*)

Read 6th December, 1906.

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I. Introduction.

There are probably few classes whose representatives (and especially larvæ and ova) suffer more from the ordinary processes of capture in a tow-net, and from preservation in company with numerous other animals, than fishes. It is consequently not in the least surprising that the results of our examination are very meagre in comparison with the amount of material submitted to us. This is, we think, inevitable, unless an expedition is so well provided with observers as to make it possible immediately to pick out and preserve fish larvæ and ova as soon as the contents of a tow-net are brought on board.

So far as the condition of our specimens bears any relation to the preserving media used, those which have been preserved in a weak solution of formalin appear to be most satisfactory; a good many tubes, however, contain larvæ blackened and shrivelled beyond recognition, probably as a result of over-fixing in some solution containing osmic acid or corrosive sublimate.

A practical observation that seems called for by the nature of the results attained is

that, to determine with any accuracy the vertical range of the ova and larvæ of fishes which live at or near the surface over deep soundings, hauls must be made with closing tow-nets through short distances in the surface-waters, particularly, we think, between 100 and 25 fathoms. Dr. Fowler's results seem to show that fish-larvæ are uncommon at the surface, and even between 25 fathoms and the surface; but between what depths in the succeeding 75 fathoms they are found, and whether there is any difference in vertical habitat between the larvæ of different species, remains yet to be investigated.

In the succeeding pages we shall first discuss the vertical distribution of the ova and larvæ recorded as a whole, secondly give a list in systematic order of the species of fish met with, together with the vertical distribution of fishes with adult characters, and lists under each species of recorded occurrences during the cruise.

II. The Vertical Distribution of Ova and Larvæ.

Though Dr. Fowler's nets naturally took only fishes of small size, it seems advisable to treat the ova and larvæ at first separately from those forms which, though small, had attained the adult conformation, and subsequently to treat the question of the vertical distribution of the adults when dealing with the individual species; in the case, however, of ova and larvæ, the number of more or less spherical objects submitted to us as possibly fish-ova, whose exact nature it has been impossible to determine, and the numerous larvæ, whose parentage and appearance in life cannot even be conjectured, make it impossible to treat the question of distribution otherwise than in the most general terms.

The following table shows the number and percentage of hauls in which "ova" and larvæ occurred:—

Depth of hauls, in fathoms.	No. at each depth.	No. containing "ova."	Percentage containing "ova."	No. containing larvæ.	Percentage containing larvæ.
0	25	7	28	2	12
25	12	3	25	8	66
50	13	4	30	12	92
75	11	2	18	11	100
100	22	8	36	17	72
150	1	....	....	....	....
200	2	....	....	1	....
250	2	2	....	2*	....
300	1	1	....	1	....
350	1	1	....	....	....

* In one of these hauls the catch was a *Gonostoma microdon* of 18 mm., perhaps hardly a larva.

The 'Research' made in all 128 tow-net hauls, of which 90 were either fished at, or were open up to, the surface, while 37 were stopped by the closing of the net at depths varying from 50 to 1500 fath. The tow-net hauls which closed below the surface include 18 which came within 300 fath. of the surface, viz. 3 closed at 300, 3 at 200, 3 at 150, 8 at 100, and 1 at 50 fath.; but none of these, nor any of the 19 hauls closed at greater depths, yielded evidence of the presence of larvæ.

Even ova taken in deep water often suffer from capture, as it is quite common to find in the 'Helga' collections tough spinous shells of the character associated by Raffaele with *Macrurus*, quite devoid of contents; and it is reasonable to suppose that broken shells of a more delicate character might easily escape observation. Very young larvæ are much more delicate than ova, and even those of littoral species are usually mangled beyond recognition in tow-net gatherings from shallow water. It may therefore be said, without the least disrespect to the skill and care employed in the sorting of the 'Research' material, that the apparent absence of larvæ from the sortings of the deeper gatherings does not absolutely prove that no young larvæ came in the way of the nets.

The table given above (so far as any conclusion can be drawn from the few taken) points to ova being fairly evenly distributed right up to the surface. In the case of larvæ it would seem that they were generally distributed between 100 and 25 fath., somewhat scarcer in the upper 25 fath., and very scarce at the actual surface. The paucity of hauls commencing at more than 100 fath. renders it impossible to say at what depth below the surface the greatest comparative density of larvæ commenced. The genus *Scopelus* we suppose to be represented in 17 gatherings, and in 16 we have noted the occurrence of *Maurolicus* or a very similar form (probably in all cases *M. borealis*); but we think that many of the young or damaged larvæ to which we have not ventured to give even a queried name may also be *Maurolicus*.

Turning to the question of diurnal oscillation of larvæ, the results seem to be negative. It is true that the only captures made by purely surface hauls took place at night, but 9 out of 11 night hauls were blank. In the hauls made from 25 to 0 fath. larvæ were taken except at midnight, 2 A.M., 6 A.M., and 8 A.M. At 50 to 0 fath. every haul, except one of two made at 4 P.M., produced larvæ, and larvæ were taken at 75 to 0 fath. throughout the 24 hours. At 100 to 0 fath. blank hauls were made at 2 A.M., 4 A.M., 7 A.M., 11 A.M., 12 noon, and 6 P.M.; but the success and failure of hauls in the hours of daylight and darkness is not in such contrast as to lead to any certain conclusion.

Taking all the superficial hauls (100–0 to 0–0 fath.) together, it is apparent that relatively to the total numbers under each condition blank hauls were more frequent by day than by night; and if we interpret the somewhat sporadic catches in the hauls of 100–0 fath. to mean that the larvæ were mostly in the upper 75 fath., there is some approach to evidence of a descent during the hours of daylight.

The fact is that the grouping of the larvæ as a whole, due to our failure to recognize the parentage of most of them, obscures the result; and we cannot treat them

separately, because many of the smaller and of the mutilated specimens may probably belong to some of the species which we have recognized.

The known larvæ of many Teleosteans evince no repugnance to the surface in calm weather. Other known larvæ seem to avoid it, and the probability is that the diurnal oscillation of Biscayan fishes represented by larvæ at the time of observation is not susceptible of generalization.

III. The Species of Fish captured.

The fishes and fish-larvæ taken by the 'Research,' so far as they are recognizable, are enumerated below; larval forms are inserted either under the genera or families to which we regard them as referable, or under names which are intended to serve no purpose beyond facilitating reference.

In the following pages are notes of the occurrences of the various species and larvæ, with a few remarks on their distribution and morphology where these appear to be called for.

So far as the larvæ are concerned, we have not attempted to describe with any completeness either forms of which our material is deficient or those better known to us from other collections which are not as yet fully worked out. In the case of the "Præscope" larva, which we have never met with in any gathering other than those made by the 'Research,' we have given a description of the stages known to us.

Very few of the fishes with adult characters, perhaps none, are sexually mature, but they have reached the phase of structural development which, in the case of the few littoral species of which the life-cycle is fairly well known, is marked by the assumption of habits approaching those of fully developed individuals. It must, however, be remembered that among littoral fishes even an approximately complete knowledge of life-history has been attained only in the case of some of the commoner species which take to the bottom when adult, and by no means extends to consistently pelagic forms. Probably all the 'Research' fishes (except, of course, the Conger) are pelagic throughout life, and there is no obvious reason why their vertical distribution should vary with age, except it be found in the greater power of the perfect individuals to respond to stimuli inducing vertical movement or in bathymetric necessities of reproduction.

So far as we are aware, Dr. Fowler's work in the 'Research' comprises the first exact records of the distances from the surface at which certain oceanic fishes have been taken.

Stomiatidæ.

Stomiatinæ.

Stomias boa, Risso.

Young specimens were taken in the following hauls:—

23 *a*. One, 47 mm.
25 *k*. Two of about 45 mm.
26 *f*. One of about 50 mm.
27 *a*. One of about 50 mm.
31 *b*. Six, 58–47 mm.
32 *o*. One of 36 mm.
32 *p*. One of 46 mm.
33 *f*. One of 46 mm.
33 *g*. One of 57 mm.
34 *d*. One of 60 mm.
36 *b*. One of 52 mm.
36 *k*. One of about 50 mm.
36 *l*. One of 51 mm.

A common species of the North Atlantic, whose occurrence in this area might be expected. The specimens taken range from 36 to 60 mm. in total length. One of the smallest (47 mm.) and one of 50 mm. occurred in nets which closed respectively at 750 and 200 fath. from the surface. The remainder were caught in hauls carried to the surface from depths of 350 fath. and less (except one taken between 1250 and 0 fath.). The largest catch, 6 specimens of 47 to 56 mm., was made between 50 and 0 fath. It would therefore appear that young examples of this species have a fairly wide vertical range.

The disclosed distribution of young *S. boa* demands some attention, for, although it is obviously unsafe to draw any positive conclusions from a species present in only 10 per cent. of the hauls made, the record is at least unproductive of evidence against diurnal oscillation in the young of this species.

Stomias boa was captured as follows:—

Hauls at	4.0 A.M. to 7.0 P.M.	7.0 P.M. to 4.0 A.M.
0	in 0 out of 13	in 0 out of 12
25	„ 0 „ 6	„ 1 „ 6
50	„ 0 „ 8	„ 3 „ 4
75	„ 0 „ 3	„ 1 „ 8
100	„ 0 „ 13	„ 3 „ 9

During daylight it was captured also at unknown horizons by open serial nets between 300 and 0, 350 and 0, 1250 and 0 fath.; it was also taken in closing-nets between 300 and 200 and between 1000 and 750 fathoms.

Sternoptychinæ.

Argyropelecus spp.

A single specimen, apparently referable to *A. olfersi*, 45 mm. in length, was taken at station 32 *n* between 100–0 fathoms at 11 P.M.

Argyropelecus larvæ similar to that already figured by us (Holt & Byrne, Ann. & Mag. Nat. Hist. ser. 7, xiv. (1904) p. 38) occurred in the following hauls:—

36 *g*. Five, 7·5 to 6·5 mm. | 36 *h*. One, 7·5 mm.

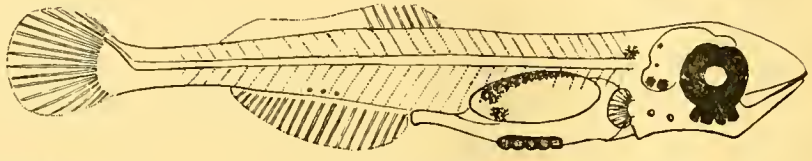
Smaller larvæ, under 3 mm. long, possibly referable to this genus, were taken in 7 other hauls, in none of which the net descended below 100 fathoms.

The area fished by the 'Research' is well within the known horizontal range of this genus, whose members are probably denizens of the surface-waters of the deep sea at all stages.

GONOSTOMATINÆ.

MAUROLICUS BOREALIS, Nilsson. (Fig. 1.)

Fig. 1.



Maurolicus borealis larva 10 mm. long. Diagrammatic camera lucida sketch, × 10·5 ca.

Larvæ referred by us to this species occurred as follows:—

25 *k*.	Four, 4·5–7 mm.	32 *n*.	Three, 8–10 mm.
30 *l*.	Nine, 6–10 mm.	36 *b*.	Two, 12–14 mm.
30 *m*.	Sixteen, 3·5–6·5 mm.	36 *c*.	Four, 3–9 mm.

It is remarkable that all these captures were made between 11.0 P.M. and 2.0 A.M.

Other larvæ, which may belong to this genus (and, presumably, species), but cannot, owing to their condition, be referred to it with reasonable certainty, were taken in ten other hauls between 100 to 25 fathoms and the surface, of which three were daylight hauls.

The area fished is well within the known horizontal range of the species. Of its vertical range we have not very much definite information, but suspect that such specimens as we have obtained from comparatively shallow water (about 110–180 fathoms) off the Irish coast were taken nearer to the bottom than to the surface.

GONOSTOMA BATHYPHILUM (Vaillant).

Twice captured:—

30 *a*.	One of 85 mm. (without caudal).	30 *i*.	One of 110 mm. (without caudal).

This species is already known from both north and south of the area fished by the 'Research.' We get it occasionally in Irish collections, but not under circumstances which indicate a much nearer approach to the surface than that shown above, while earlier records all deal with captures made in nets sunk to over 1000 fathoms.

GONOSTOMA MICRODON, Günther.

Once recognized in haul:

36 *h*. 250–0 faths., 10 A.M. One of about 18 mm.

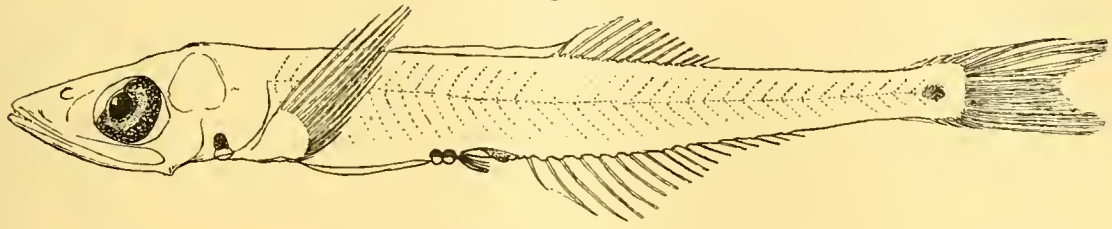
In the Irish collections this fish is common in nets lowered to considerable depths. We know of no record which proves its occurrence, in Atlantic or Pacific, at much less than 265 fathoms.

Fish-remains from the following hauls, 32 *g*, 32 *o*, 34 *f*, 35 *c*, may possibly be referable to this species. If, in fact, so referable they considerably extend its proved upward vertical range.

The following larva appears to us to be clearly referable to Boulenger's subfamily *Gonostomatinæ*.

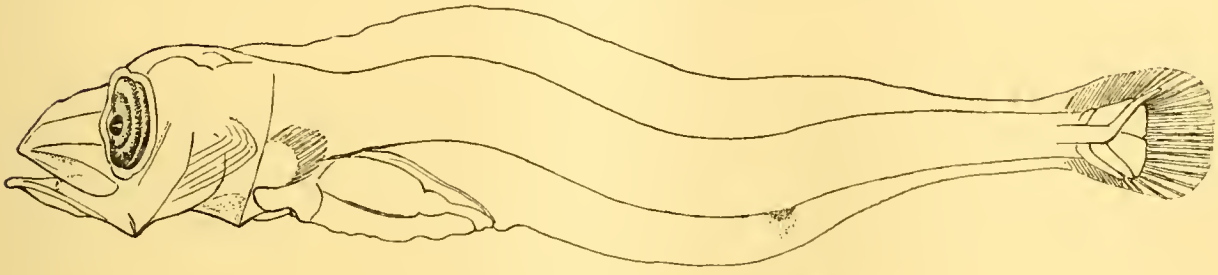
"Præscope" Larva. (Figs. 2 & 3.)

Fig. 2.



"Præscope" larva 15 mm. long, × 10 ca.

Fig. 3.



"Præscope" larva 9 mm. long, × 17·5 ca.

Specimens of this form occurred in the following hauls:—

24 *b*. One of 13 mm.
24 *e*. Two of 15 mm.
35 *d*. One of 9 mm.

Small elongate larvæ, of which some may probably be identified with this form, occurred in one of the above hauls and five others, all fished from between 100 or 50 fathoms and the surface at various hours of the day and night. None of these latter larvæ, however, have any characters of a nature sufficiently definite to permit of their reasonably certain association with this form.

The evidence of vertical range is too slight to permit of any conclusions being drawn, but it is worth noting that the "Præscope" larva has not been found in any haul commencing nearer the surface than 50 fathoms and only certainly identified in hauls commencing at 100 fathoms. This form has not been recognized by us in any of the large collections made by the 'Helga' in deep water off the west and south-west coasts of Ireland, and we accordingly append a somewhat fuller description than in the case of larvæ of which we may reasonably anticipate a fuller material in the near future.

The most advanced specimens measure 15 mm. and have the form shown in fig. 2. The head is a little longer than the abdomen, and head and abdomen together comprise a little less than half of the total length without the caudal fin. The eye is relatively large, but not remarkably so for a larva. It is somewhat forwardly directed, as in many deep-sea larvæ and, to a less extent, in the adults of deep-sea fishes. The snout is long and sharply pointed in lateral view. Its sides are subvertical and sharply defined from the flattened upper surface. The angle of the jaw reaches or passes the vertical from the hind edge of the eye. The teeth appear to be rather small and, as usual in larvæ, set at considerable intervals. The pectoral fins are large and set low down on the body; they would extend if perfect at least to the anus. The ventrals are small and situated a little way in front of the anus. The dorsal shows from 10 to 12, and the anal 13 to 17 rays, but when the larvæ are examined from the ventral aspect it appears probable that in the adult condition the anal is continued further back than appears in the figure. The dorsal commences a little behind the origin of the anal. There is a low fold of embryonic marginal fin in front of the dorsal, commencing at some distance behind the head, and a similar ventral fold between the bases of the pectorals and ventrals. The caudal is of moderate length and rather deeply forked. An adipose fin, if present in the adult, would probably be conspicuously indicated by embryonic rays at this stage of development, but cannot be detected in any of the specimens. There are about 15 abdominal and about 21 caudal myomeres, but the exact count is uncertain.

On the lower edge of each gill-cover, or on the isthmus internal to it, is a large photophore, consisting of a base of black matter and a rounded opaque white apex. Four similar bodies, set in two closely apposed pairs, occur on the abdomen immediately in front of the ventral fins. The larvæ are devoid of dark pigment, other than that of the eyes, except for a black spot in front of the caudal base.

A specimen of 13 mm. shows 12 dorsal and 15 anal rays, and has the snout somewhat arcuate in dorsal profile. This last feature appears to connect the stage of fig. 2 with the larva depicted in fig. 3, which measures 9 mm. So far as we can count, the myomeres are of the same number as in the larger specimens. The position of the alimentary canal, which is slung obliquely from the trunk in the ventral marginal finfold, may be due in some measure to post-mortem distortion. About midway in the caudal region the trunk shows a ventral opaque excrescence, of which the nature is not apparent. It does not look like any phase in the development of an anal fin and may probably be due to injury.

Though the collection comprises a number of small elongate larvæ of which some may probably be specifically identical with "Præscope," none have any characters of a nature sufficiently definite to permit of their reasonably certain association with this form.

A process of elimination causes us to regard this larva as that of a member of the *Gonostomatinæ*. The suggestion of a probable parent is not easy: a comparison with the adults of known genera and species points to *Gonostoma* itself; and, although it would *prima facie* appear improbable that a *Gonostoma* would attain its adult characters through an early stage resembling the "Præscope" larva, we cannot premise that fishes

whose phylogeny is at best imperfectly known may not in their ontogeny pass through phases considerably different from the adult condition. It may be remarked that (to judge from figures) *Photichthys* (including Goode and Bean's *Yarrella*) has a great look of the "Præscope" larva, which may be referable to some undiscovered member of that genus. So far as *Gonostoma* is concerned, two species, *G. microdon* and *G. bathyphilum*, occur in the areas worked by the 'Research' and the 'Helga,' the first being exceedingly common, the second apparently scarce: *G. microdon* seems an almost impossible parent for this larva from considerations of size, quite apart from anything else; *G. bathyphilum* may be responsible, but if so the absence of this larva from the Irish collections is somewhat remarkable.

Anguillidæ.

Conger vulgaris, Cuvier.

A *leptocephalus* larva of this species, 132 mm. long, was taken at Station 30 *m* between 25 fathoms and the surface at about 11 P.M. This capture over soundings of more than 2000 fathoms seems to indicate a considerable horizontal wandering from the normal haunts of the adult (which is not known, we believe, to descend to much beyond 400 fathoms), but is in consonance with other records of its *leptocephalus* stage (*cf.* Schmidt, Cons. Intern. Exp. Mer, Rapp. et Proc. Verb. v. p. 137 [1906]).

Scopelidæ.

Scopelus rafinesqui, Cocco.

A single specimen, about 40 mm. long, was taken at Station 36 *d* between 50 fathoms and the surface at about 1 A.M.

This capture is in consonance with what we already know of the vertical and horizontal distribution of the species.

Scopelus glacialis, Reinhardt.

29 *a*. One, about 19 mm.
31 *b*. Three, 46 mm., 29 mm., and 21 mm.
32 *p*. One, about 13 mm.
33 *d*. One, about 18 mm.
33 *f*. One, about 15 mm.
34 *a*. One, about 20 mm.
34 *c*. One, about 21 mm.
34 *d*. One, about 20 mm.
35 *c*. One, about 16 mm.

These records help to extend the known horizontal range of this species in a southward direction, and we can now trace a continuous distribution on the eastern side of the Atlantic from Greenland *viâ* the coast of Norway, the Färoe Channel, and the west coast of Ireland to the North Biscayan region, while Dr. Wolfenden in the 'Silver Belle' took it in Feb. 1906 in the Mediterranean off Marbella, about 20 miles N.E. of Gibraltar. Fowler's conclusions (P. Z. S. 1898, pp. 559–560), based on a summary of the then existing records, as to the thermal limitations of its range, would appear to require some modification, since the largest 'Research' specimen was taken at not more than 50 fathoms from the surface, and we understand that the net used in haul 29 *a* ("mesoplankton trawl") might have admitted a small fish during its ascent to the

surface. The American and Irish material, taken in open nets, afford no certain indication of vertical position of capture, and may have been taken in either warm or cold water. Attention may be drawn to the fact that all the specimens except that in haul 29 *a*, between 500 and 250 fathoms, were taken by night, and our remarks on the possible vertical oscillation of *Stomias boa* apply, though in less degree, to this species.

The following larval forms seem undoubtedly referable to this family and to the genus *Scopelus*.

1. Scopelid Larva "R 1."

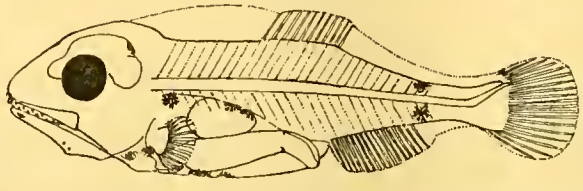
A larva closely resembling that of *S. glacialis* (see Holt, P. Z. S. 1898, p. 550), with which it is not improbably identical, although it seems to be rather smaller at corresponding stages of development. It was taken in the following haul:—

32 *g*. One of 6 mm.

Our material does not permit of a detailed description of any practical utility being given.

2. Scopelid Larva "R 2." (Fig. 4.)

Fig. 4.



Scopelid larva "R 2" 8 mm. long. Diagrammatic camera lucida sketch, × 9 ca.

These larvæ were of somewhat frequent occurrence, and were recognized in more or less damaged condition in the following hauls:—

30 *f*. Four, 6·5–8 mm.	32 *o*. Five, 4–8 mm.
30 *l*. Five, 6·5–8·5 mm.	33 *f*. One, 6·5 mm.
31 *b*. Four, 4·5–8·5 mm.	36 *b* *. One, remains ca. 10 mm.

They closely resemble the larvæ of *S. glacialis*, but are smaller and deeper in the body, with a longer and more conical snout. Our diagram, taken from a specimen 8 mm. long, may be compared with the larva of *S. glacialis* figured by Holt (P. Z. S. 1898, p. 550) at the same length, and should suffice to show these differences.

3. Scopelid Larva "R 3."

A larva which is larger than that of *S. glacialis* at corresponding stages, and has a more elevated head and more abrupt profile, occurred in more or less damaged condition in hauls:

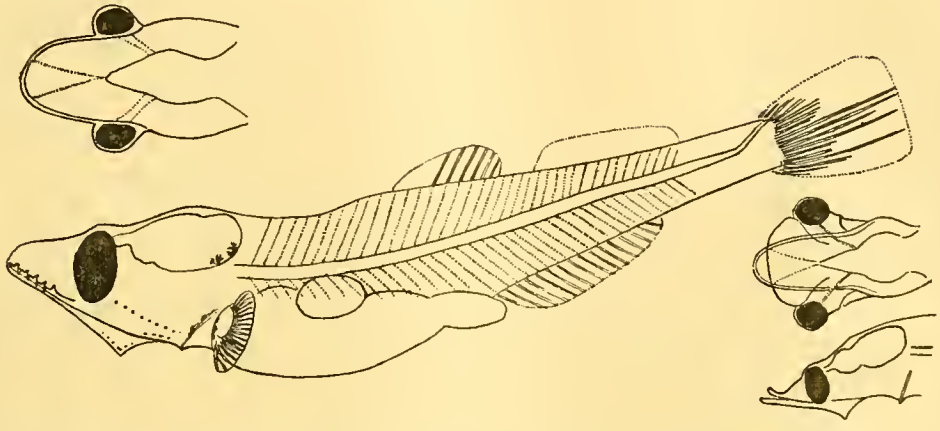
30 *l*. One, with a head 2·25 mm. long.	32 *n*. One, 9 mm. long.

* There seems some doubt as to this record, as the label reads 36 *b* (?).

Their condition does not permit of a figure or detailed description being given, but they may conceivably be referable to *Scopelus rafinesqui* *.

"Periscope" Larva. (Fig. 5.)

Fig. 5.



"Periscope" larva 12 mm. in length, with view of head seen from above, and views from above and the side of head of a smaller example 9 mm. long. Diagrammatic camera lucida sketch, × 9 ca.

This larva occurred as follows:—

25 *k*.	One, 6·5 mm.	32 *m*.	One, 8·5 mm.
30 *h*.	One, 5 mm.	32 *o*.	One, 4·5 mm.
30 *l*.	Two, 9 and 12 mm.	33 *c*.	One, 5 mm.
31 *b*.	One, 7 mm.	35 *b*.	One, 4 mm.

Other specimens, possibly referable to the same form, were present in two other hauls.

It is a larva of the same type as that described by Lo Bianco (Mitth. Zool. Stat. Neap. xvi. p. 109 [1903]), and a comparison with Holt's figures (*loc. cit.*) of *Scopelus glacialis* and the larva termed by us "R 2" suggests that it certainly belongs to the family Scopelidæ, and not improbably to some species of *Scopelus*.

Our smaller material shows no diagnostic characters beyond the form of the head and eyes, and is not in good condition.

Our diagrams of a specimen 12 mm. long and of the head of a smaller specimen of 9 mm. sufficiently show its characteristics at these sizes. The pedunculate character of the eyes in the younger examples has probably no exact value in classification, as we meet with exactly the same character in another larva (not taken by the 'Research'), in which the abdomen extends almost to the posterior extremity.

* *S. punctatus*, being very abundant at times off the south-west of Ireland, may not improbably be the parent of one of the species of larvæ.

Syngnathidæ.

Nerophis æquoreus, var. exilis, Holt & Byrne.

Occurred as follows:—

21 *g*. One, 12 mm.
21 *i*. One, 13 mm.
24 *i*. One, 8 mm.
25 *e*. One, 8 mm.
25 *k*. One, 72 mm.
30 *b*. Five, 9–15 mm.
30 *f*. One, 97 mm.
30 *g*. One small.
30 *l*. One small and part of brood-matrix.
31 *b*. Four, 100–108 mm.; four, 7–17 mm.
33 *a*. One, 21 mm.
33 *b*. One, 11 mm.
34 *a*. One, 90 mm.; fifteen, 8–18 mm.
34 *g*. Two, 8 and 11 mm.
35 *f*. One, 7 mm.
36 *b*. One, 15 mm.

Here, as on the west coast of Ireland, common at or near the surface at all stages (see Holt & Byrne, Fish. Ireland, Sci. Inv. 1905, ii.). We have little doubt that the specimens taken by the 'Caudan' further south in the Bay, and recorded as *Syngnathus*, are also referable to this form (Koehler, 'Campagne de Caudan,' 1896). We have no evidence of its occurrence, either at the bottom or as a pelagic organism, below 100 fathoms.

Carangidæ.

Caranx trachurus, L.

Once met with:

34 *d*. One of 80 mm.

This capture rather suggests that the net encountered a straggler from the protection of a *Rhizostoma* or some other large Medusa, which may have drifted seawards from the place at which it collected its *clientèle*, but little is really known of the movements of either the cœlenterate host or the parents of its fish *protégés*. Scad appear near the coast, in varying number according to the year, in summer and autumn, and their presence in coastal waters may be occasionally demonstrated in winter by the examination of stomachs of larger fish.

Incertæ sedis.

"Long-anal" Larva.

This larva was taken in the following hauls:—

32 *p*. One of 27 mm.
35 *c*. One of 14 mm.

but is chiefly known to us from other collections. Fragmentary remains in haul 32 *i* may also be referable to it. It is an elongate form characterized by a long pointed snout, very short abdomen, and by the very early development of an anal fin immediately in front of the caudal. The sides of the abdomen are decorated by a series of large black patches separated by narrow vertical unpigmented interspaces. A similar interspace separates the black patches of each side. Towards the caudal extremity are a number of small patches of internal pigment above and below the vertebral column.

This larva may probably be related to the Stomiatidæ, but it reaches a comparatively large size without approaching the characters of any adult fish known to us. It has a superficial resemblance to *Paralepis coregonoides*, but the abdomen is no longer than the head, which is sufficient to eliminate the last-named species and its allies from the list of possible parents.

"Scorpæniform" Larva.

In the following hauls:—

26 *c*. One of 4 mm.	34 *c*. One of 3·5 mm., one of 6·3 mm.

there occurred a "Scorpæniform" larva which, at a length of 6·3 mm. (without caudal fin), is a massive little fish having the general conformation of an adult *Scorpæna*; but as the only specimen of this size is in very bad condition, its true relationships are matter of conjecture. It is certainly not *S. dactyloptera*.

Larvæ of about 3·5 and 4 mm., which we think belong to the same form, have the body rather elevated, and adorned, after preservation in formalin, with rusty-brown pigment along the divisions of the myomeres, except at the anterior and posterior extremities.

"Trigloid" Larva.

We have listed as "Trigloid" a much-macerated larva some 4·5 mm. long from haul 36 *d*, 50–0 fathoms, about 1 A.M., which may, when perfect, have had characters similar to those of a larval *Trigla*.

NOTE TO THE FOREGOING REPORT.

By G. Herbert Fowler, *F.L.S.*

As Messrs. Holt and Byrne point out, the numbers of observed larvæ which they were able to furnish are not necessarily to be regarded as absolutely accurate; for these objects are so delicate that further specimens may have been reduced to mere unrecognizable fragments. Exactly the same reservation has, of course, to be made in all those cases which I have endeavoured to treat statistically in former reports. They do not profess to give an absolute, but a comparative, result; a comparison of haul with haul, or of depth with depth, during the particular period of that cruise, is feasible, because there is no reason to suppose that the destruction of specimens was proportionately greater at one particular depth than at any other (except in the case of the deep serial hauls, which have always been kept in a different category).

While, then, no single species was sufficiently plentiful or occurred with sufficient regularity to allow of statistical treatment, there seems to be no reason why the pelagic fish-larvæ as a whole should not be so handled. There were about 230 of these.

The following table, for example, seems to show a concentration of the larvæ below the surface, but short of 100 fathoms, whether considered from their number of occurrences * or from the average specimens per hour haul †.

In hauls with open nets at	fathoms, larvæ occurred as	average specimens per hour haul.
0	0·2	
25	4·6	
50	5·6	
75	4·0	
100	2·3	

Further, a comparison of the hauls made in the dark hours with those made in daylight seems to point to a slight upward movement of the larvæ at night; the concentration of specimens rising from 75 fathoms to 25–50 fathoms. How far this may be due to larvæ rising from the mesoplankton below 100 fathoms it is impossible to say, but it seems obvious that there was a great concentration of fish-larvæ at 25–50 fathoms during the dark hours.

Depth in fathoms.	4.0 A.M. to 7.0 P.M.		7.0 P.M. to 4.0 A.M.	
	Number of hauls.	Average specimens per hour.	Number of hauls.	Average specimens per hour.
0.....	9	0·0	7	0·5
25.....	6	2·8	6	6·5
50.....	8	2·6	5	10·6
75.....	3	3·6	8	4·2
100.....	13	2·0	9	2·6

The following table exhibits the distribution of the captures by hauls and depths (L = larvæ). The first three hauls were made with the closing "mesoplankton trawl."

* Compare p. 190, above.

† In these tables the actual numbers have been treated as in previous papers of the series, and hauls with the net of 180 meshes per inch omitted.

Depth in fathoms.	Haul.	Ova.	Larvæ.	*Stomias boa.*	"Long-anal" larva.	*Argyropelecus.*	*Maurolicus borealis.*	*Gonostoma bathyphilum.*	*Gonostoma microdon.*	"Prescope" larva.	*Scopelus Rafinesqui.*	*Scopelus glacialis.*	Larva R 1.	Larva R 2.	Larva R 3.	"Periscope" larva.	*Conger vulgaris.*	*Nerophis æquoreus*, var. *exilis.*	*Caranx trachurus.*	"Scopæniform" larva.	"Trigloid" larva.	Undetermined larvæ.
500—250	29 *a*	..	..	..	..	..	..	..	..	..	..	+										
1500—750	30 *a*	..	..	..	..	..	..	+														
2000—1000	30 *e*	..	..	..	..	..	..															
0	21 *e*																					
	21 *f*																					
	21 *i*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+					
	22 *d*	+	L	..	..	L?																
	22 *e*	+																				
	22 *g*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	23 *b*	+																				
	23 *c*																					
	23 *d*	+																				
	23 *e*																					
	24 *c*																					
	24 *f*																					
	24 *g*	+																				
	24 *h*																					
	24 *i*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+					
	24 *k*	+																				
	25 *a*																					
	25 *b*																					
	25 *h*																					
	25 *i*																					
	25 *l*																					
	30 *c*	+																				
	32 *c*																					
	33 *a*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+					
	33 *b*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+					
25—0	26 *a*	+	L	..	..	L?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	30 *b*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+						
	30 *m*	+	L	..	..	..	L	..	..	..	..	..	..	..	..	..	L	..	..	..	..	..	..	L
	31 *a*	..	..	L																				
	32 *b*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	32 *e*	..	..	L																				
	33 *e*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	33 *g*	..	L	+	..	..	L?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	34 *a*	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	+						
	34 *g*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	L
	35 *w*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	36 *c*	+	L	..	..	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
50—0	21 *g*	+	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	L
	25 *e*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+						
	25 *g*	..	L	..	..	..	L?																	
	25 *k*	..	L	+	..	..	L	..	..	..	..	..	..	..	..	L	..	+						
	26 *c*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L	..	L	
	30 *d*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L	
	30 *l*	..	L	..	..	..	L	..	..	..	..	..	..	L	L	L	..	+	..	..	..	..	L	
	31 *b*	..	L	+	..	..	L?	..	..	..	..	+	..	L	..	L	..	+	..	..	..	..	L	
	32 *a*	+	L	..	..	..	..	..	..	..	..	..	..	..	..	L?	..	..	..	..	..	..	L	
	32 *h*	..	L	..	..	L?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L	
	33 *c*	+	L	..	..	..	..	..	..	..	..	..	..	..	..	L	..	..	..	..	..	..	L	
	33 *f*	+	L	+	..	..	L?	..	..	..	..	+	..	L	..	..	..	..	..	..	..	..	L	
	36 *d*	..	L	..	..	..	L?	..	..	L?	+	..	..	..	..	..	..	..	..	..	..	L	L	
75—0	30 *f*	..	L	..	..	..	..	..	..	..	..	..	..	L	..	..	..	+	..	..	..	..	L	
	32 *g*	..	L	..	..	..	L?	..	..	L?	..	..	L	..	..	..	..	..	..	..	..	..	L	
	32 *m*	+	L	..	..	..	L?	..	..	..	..	..	..	..	..	L	..	..	..	..	..	..	L	
	32 *o*	..	L	+	..	..	..	..	..	..	..	..	..	L	..	L	..	..	..	..	..	..	L	
	33 *h*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L	
	34 *c*	+	L	..	..	..	L?	..	..	..	..	+	..	..	..	..	..	..	..	L	..	..	L	
	35 *a*	..	L	..	..	L?	..	..	..	L?														
	35 *c*	..	L	..	L	..	..	..	..	..	..	+												
	35 *e*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L
	35 *y*	..	L	..	..	..	..	..	..	L?														
	36 *a*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	L

Depth in fathoms.	Haul.	Ova.	Larvæ.	*Stomias boa.*	"Long-anal" larva.	*Argyropelecus.*	*Maurolicus borealis.*	*Gonostoma bathyphilum.*	*Gonostoma microdon.*	"Præscope" larva.	*Scopelus glacialis.*	Larva "R 2."	Larva "R 3."	"Periscope" larva.	*Nerophis æquoreus,* var. *exilis.*	*Caranx trachurus.*	Undetermined larvæ.
100—0	21 *h*																
	21 *l*																
	22 *a*	+	L	..	..	L?	..	..	..	..	..	..	..	..	..	..	L
	24 *b*	+	L	..	..	..	..	..	..	L							
	24 *d*																
	24 *e*	..	L	..	..	..	..	..	..	L							
	25 *d*	+	L	..	..	L?	L?	..	..	..	..	..	..	..	..	..	L
	30 *g*	..	L	..	..	..	..	..	..	..	..	..	..	..	+	..	L
	30 *h*	+	L	..	..	..	..	..	..	..	..	..	..	L			
	32 *d*	..	L	..	..	..	..	..	..	L?	..	..	..	..	..	..	L
	32 *i*	+	L	..	L?												
	32 *n*	..	L	..	..	+	L	..	..	..	..	..	L	..	..	..	L
	32 *p*	+	L	+	L	..	L?	..	..	..	+	..	..	..	..	..	L
	33 *d*	..	L	..	..	..	..	..	..	..	+	..	..	..	..	..	L
	34 *b*	+															
	34 *d*	..	L	+	..	..	..	..	..	..	+	..	..	..	..	+	L
	35 *b*	+	L	..	..	L?	..	..	..	..	..	..	..	L	..	..	L
	35 *d*	..	L	..	..	..	..	..	..	L							
	35 *f*	..	..	..	..	..	..	..	..	..	..	..	..	..	+		
	35 *x*	..	L	..	..	..	..	..	..	..	..	..	..	L?	..	..	L
	36 *b*	..	L	+	..	..	L	..	..	..	..	L	..	..	+		
	36 *e*	..	L	..	..	..	..	..	..	..	..	..	..	..	..	..	L
150—0	36 *f*																
150—50	21 *p*																
150—100	21 *n*																
200—0	21 *a*																
	36 *g*	..	L	..	..	L											
200—100	21 *b*																
	21 *o*																
	26 *e*																
	34 *h*																
	35 *m*																
	35 *n*																
	35 *t*																
250—0	36 *h*	+	L	..	..	L	..	..	+								
	36 *i*	+	L	..	..	..	..	..	..	..	..	..	..	..	..	..	L
250—150	35 *o*																
	35 *p*																
	35 *s*																
300—0	36 *k*	+	L	+	..	..	..	..	..	..	..	..	..	..	..	..	L
300—200	21 *c*																
	26 *f*	..	..	+													
	35 *l*																
350—0	36 *l*	+	..	+													
400—300	21 *k*																
	32 *l*																
	35 *k*																
500—400	21 *m*																
	35 *h*																
	35 *i*																
750—500	22 *b*																
	30 *k*																
	34 *e*																
	34 *f*	..	..	..	..	..	..	..	+?								
1000—750	23 *a*	..	..	+													
	27 *c*																
	31 *d*																
	32 *f*																
	32 *k*																
1250—1000	24 *a*																
	27 *b*																
	31 *c*																
1500—1250	25 *f*																
	30 *i*	..	..	..	..	..	..	+									
2000—1500	25 *c*																
	26 *b*																

BISCAYAN PLANKTON.

Part XI.—DECAPODA.

By Stanley W. Kemp, *B.A.*
(*Communicated by* Dr. G. Herbert Fowler, *F.L.S.*)

BIOLOGICAL LABORATORY WOODS HOLE LIBRARY MASS.

(Plates 14 & 15.)

Read 7th March, 1907.

So will be readily understood, the large majority of the Decapoda collected by Dr. Fowler in the Bay of Biscay are larval forms.

Tow-nets, unless of exceptional size, are but ill adapted for the capture of free-swimming Macrura, many of which are powerful swimmers and easily avoid capture in small nets. Nevertheless, five species are represented by specimens which have attained adult characters; they are—*Amalopenæus elegans*, Smith, *Sergestes arcticus*, Kr., *Acanthephyra purpurea*, A. M.-Edw., *Acanthephyra* (*Systellaspis*) *debilis*, A. M.-Edw., and *Hymenodora glacialis*, Buchholz. The last named is represented only by macerated fragments, and its identification therefore cannot be regarded as absolutely satisfactory.

So far as is at present known, only a small percentage of Macrura are pelagic, so that the five species mentioned above probably represent about one-half of the free-swimming forms which might occur in the district under observation.

The chief interest of the collection centres in the fine series of larval *Acanthephyra purpurea*. The later stages in the development of this form have been determined by Coutière, and the material before me enables me to substantiate his suggestion that the species leaves the egg in the form of a zœa. A comparison of the development of this species with that of *A. debilis* renders this feature noteworthy enough: *A. debilis* has much larger eggs than *A. purpurea*, and Coutière states that the young leave the egg in a post-larval condition *.

This series of young *A. purpurea* comprises the vast majority of the larvæ in the collection, but in addition there are a few interesting Hippolytidæ closely allied to Spence Bate's larval genus *Caricyphus*. Only three larval Anomura are present; and Brachyura are represented by a few metazoææ and megalopæ. Numerous examples of all these larvæ occur in our extensive material from the west coast of Ireland, and it seems best to defer any detailed notice of the few specimens taken in the Bay of Biscay until such time as I can deal with this large collection, which will probably enable many of them to be connected with well-known adult forms.

* This statement is, however, incorrect: see note on p. 214.

All the specimens were taken in approximately the same locality, between latitude 46° 43′ to 47° 29′ North, and longitude 7° 15′ to 8° 18′ West. The soundings in this area are 2000 fathoms or more.

MACRURA.

Amalopenæus elegans, Smith.

Examples of this species are present in two hauls, the nets fishing between 350 fathoms and the surface (36 *l*), and between 1250 fathoms and the surface (27 *a*). Three small specimens were taken; two measure only 11·5 mm., and the third is broken.

Fragments of two individuals, which almost certainly belong to this species, occur in another haul between 500 and 400 fathoms (35 *i*).

Sergestes arcticus, Kröyer.

Eighteen examples of this well-known N. Atlantic form are present in the collection; they range in size from 8 to 27 mm.: the smaller specimens have evidently only recently emerged from the *Mastigopus* stage. One individual measuring only 14 mm. possesses antennæ 54 mm. in length.

All the specimens which can definitely be referred to this species were caught between 100 fathoms and the surface, some actually at the surface. Fragments, in all probability of *S. arcticus*, are present in nets fishing between 200 and 100 fathoms, and between 500 and 400 fathoms.

Larval Sergestidæ.

Two *Acanthosoma* larvæ and several *Elaphocaris* were caught, all in the upper strata of the water.

Acanthephyra purpurea, A. Milne-Edwards *. (Pl. 14 and Pl. 15. fig. 1.)

A mature male, 81 mm. in length, was caught in haul 36 *b* between 100 fathoms and the surface. The specimen may be referred to Coutière's var. *multispina*; the rostrum bears ten teeth above and six below; the carinæ of the last four abdominal somites are produced posteriorly as spines, that of the third being the longest, the other much shorter and subequal. The telson is furnished on the right side with nine, and on the left with ten, dorso-lateral spinules.

More than fifty larvæ of this species are present in the collection †; they range in size from specimens which can only just have left the egg up to those which were described by Coutière under the name of *parva*. This author soon realised that he was dealing with larval *A. purpurea*; and in a paper published shortly afterwards (Bull. Mus. Oceanogr. Monaco, No. 70, 1906) he gives a complete account of the development from

* A full discussion of the somewhat lengthy synonymy of this species will be found in my paper, "On the Occurrence of Two Species of *Acanthephyra* off the Coast of Ireland," Fisheries, Ireland, Sci. Invest. 1905, i. (1906).

† In addition to those shown in the table of comparable hauls (pp. 216, 217), three specimens were taken in 21 *d*, 100 to 0 fathoms.

the *parva* stage onwards. He did not possess any younger specimens, but suggested that the earliest form was in all probability a zoæa. The material in my hands enables me to confirm this view. In the case of *Acanthephyra* (*Systellaspis*) *debilis*, a species of which the development is now almost completely known, the larva is born with the pereiopods fully formed and the pleopods present as buds; in this instance, however, the ova are relatively of a much greater size than is the case with *A. purpurea*.

The following table shows some of the features of the specimens examined, excluding those which were too broken to afford accurate data. The rostral length is subject to considerable variation during the different stages: I have therefore measured the specimens from the blunt tooth, which is situated at the base of the rostrum, to the tip of the telson (excluding setæ); in the younger forms this tooth is a very prominent characteristic, and it appears to persist throughout the stages as the posterior dorsal spine of the rostrum.

Haul.	Length, mm.	Rostral formula.	Stage.	Haul.	Length, mm.	Rostral formula.	Stage.
22 *a*	4·3	$\frac{1}{0}$	No uropods or pleopods.	32 *p*	5·6	$\frac{1}{0}$	Uropods free, no pleopods.
26 *c*	4·3	$\frac{1}{0}$	,, ,,	30 *l*	5·7	$\frac{1}{0}$	,, ,,
30 *f*	4·3	$\frac{1}{0}$	,, ,,	26 *a*	5·9	$\frac{1}{0}$	,, ,,
36 *f*	4·3	$\frac{1}{0}$	,, ,,	30 *l*	5·9	$\frac{1}{0}$	,, ,,
34 *b*	4·4	$\frac{1}{0}$	,, ,,	32 *o*	5·9	$\frac{1}{0}$	,, ,,
34 *d*	4·4	$\frac{1}{0}$	,, ,,	36 *b*	6·0	$\frac{1}{0}$	,, ,,
33 *c*	4·5	$\frac{1}{0}$	,, ,,	36 *b*	6·1	$\frac{3}{0}$	,, ,,
26 *a*	4·6	$\frac{1}{0}$	,, ,,	32 *a*	6·3	$\frac{1}{0}$	,, ,,
26 *a*	4·6	$\frac{1}{0}$	,, ,,	30 *l*	6·6	$\frac{1}{0}$	,, ,,
30 *f*	4·6	$\frac{1}{0}$	,, ,,	32 *m*	6·6	$\frac{1}{0}$	,, ,,
30 *l*	4·6	$\frac{1}{0}$	,, ,,	21 *d*	9·1	$\frac{3}{0}$	With both uropods and pleopods; eyes large.
30 *l*	4·6	$\frac{1}{0}$	,, ,,				
30 *l*	4·6	$\frac{1}{0}$	,, ,,	32 *a*	9·4	$\frac{3}{0}$	,, ,,
30 *l*	4·6	$\frac{1}{0}$	,, ,,	25 *g*	10·4	$\frac{3}{0}$	,, ,,
32 *p*	4·6	$\frac{1}{0}$	,, ,,	25 *g*	11·6	$\frac{5}{0}$	,, ,,
36 *e*	4·6	$\frac{1}{0}$	,, ,,	21 *d*	11·7	$\frac{4}{0}$	,, ,,
33 *f*	4·8	$\frac{1}{0}$	,, ,,	25 *k*	12·0	$\frac{4}{0}$	,, ,,
26 *a*	5·0	$\frac{1}{0}$	,, ,,	32 *m*	12·0	$\frac{4}{0}$	,, ,,
30 *l*	5·0	$\frac{1}{0}$	Uropods free, no pleopods.	32 *m*	12·1	$\frac{4}{0}$	,, ,,
34 *g*	5·0	$\frac{1}{0}$	,, ,,	33 *g*	12·1	$\frac{4}{0}$	,, ,,
36 *b*	5·1	$\frac{1}{0}$	,, ,,	21 *m*	12·3	$\frac{8}{0}$	Eyes small, "*parva*" form.
30 *g*	5·2	$\frac{1}{0}$	No uropods or pleopods.	34 *f*	12·5	$\frac{6}{0}$	,, ,,
30 *l*	5·2	$\frac{1}{0}$	Uropods free, no pleopods.	32 *h*	13·0	$\frac{5}{0}$	With both uropods and pleopods; eyes large.
30 *l*	5·5	$\frac{1}{0}$	,, ,,				
30 *l*	5·5	$\frac{1}{0}$	,, ,,	30 *l*	13·2	$\frac{5}{0}$	,, ,,
30 *l*	5·5	$\frac{1}{0}$	,, ,,	25 *g*	13·4	$\frac{5}{0}$	,, ,,

The figures in the second column can only be regarded as approximate, for the accurate measurements of specimens possessing varying degrees of curvature is necessarily attended with some difficulty.

The smallest specimen in the collection measures about 4·3 mm., and there can be no doubt that the larva is but little smaller than this when it leaves the egg.

As will be seen from the table, the collection contains nineteen specimens, ranging from 4·3 to 5·2 mm., in which neither uropods nor pleopods are developed; these represent the earliest stage * in the metamorphosis (Pl. 14. figs. 1–8, 11, 14, and 18).

* It will of course be understood that the word "stage" is merely used to distinguish larval groups differentiated

The rostrum is very slender and nearly as long as, or rather longer than, the carapace; it bears a blunt spine at its base immediately over the posterior edge of the orbit. The carapace is rather less than twice as long as broad; it is provided with a blunt spine in the mid-dorsal line near the hinder margin, and occasionally with two or three extremely minute spinules on the posterior basal edge; the orbital angle is obtuse and rounded, the antero-lateral angle is produced forwards as a long, slender, upcurved spine.

The 3rd abdominal somite is deep, dorsally rounded in side view, and produced posteriorly in the form of a hood over the 4th somite. The 6th somite is not marked off from the telson; the two together are about four times the length of the 5th somite. The telson (fig. 18) is wide, rather deeply emarginate apically, and is furnished on each side with eight setæ. The uropods are not free, but in some of the specimens, which are evidently about to moult, they may easily be seen lying within the telson (fig. 19); in these cases the telson itself is retracted somewhat from the outer edge, a fine filament extending from it down each seta.

The eye (fig. 14) is about as long as the carapace, and is widest across the cornea; the latter is black and hemispherical, and is composed of approximately 200 to 300 facets.

Eight pairs of limbs are present, the antennules, the antennæ, the mandibles, two pairs of maxillæ, and three pairs of maxillipedes. No pereiopods are developed in this stage, but one or two pairs may be represented by buds.

The antennules (fig. 2) reach slightly beyond the eyes; the peduncle is in some cases two-jointed, in others, in which development has proceeded somewhat, three-jointed. The basal joint is long and shows no trace of the lateral process. The outer flagellum is rather stout, not longer than the ultimate peduncular segment, and is furnished with a few setæ at its apex. The inner flagellum is represented merely by a rounded boss bearing a stout plumose seta of varying length.

The antennæ (fig. 11) scarcely reach to the end of the antennular peduncle; the single basal joint is as long and as wide as the scale, the latter being elliptical in shape and provided with 10 to 15 finely plumose setæ; the distal spine is not present, and the extreme apex is divided by two or three faint transverse articulations. The distal end of the basal segment bears on its inner side a stout seta rather longer than the scale; this doubtless functions as a flagellum.

The mandibles (fig. 3) show no trace of a palp, distally they are almost squarely truncate and are provided with a few minute teeth. The 1st maxilla (fig. 4) consists of the two basal lobes and an endopod. The lower lobe is rounded and furnished with about six setæ, the upper rather longer with a narrow truncate apex armed with a few short bristles. The endopod bears two setæ at about the middle of its internal margin and four at the apex. The 2nd maxilla (fig. 5) is widest basally, the internal margin is four-lobed, each lobe being provided with numerous setæ; the endopod also bears several setæ, while the oval exopod, which reaches to about half the length of the palp, is furnished with five setæ.

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by sets of characters by which they may be readily recognized. The term has no special significance, nor is it possible, in the present species, to say how many moults are included in each.

The three pairs of maxillipedes (figs. 6, 7, and 8) have long exopods tipped with three or four long hairs. The endopod is four-jointed, the joints being narrow and subcylindrical, and each provided with one or two setæ. In the first two pairs the endopods are shorter than the exopods, in the third pair they are equal, or the endopod is slightly the longer.

In the larger specimens in this stage buds representing the first appearance of the two anterior pairs of pereiopods may be observed. Those of the first pair are longer than those of the second, and are curved forwards between the bases of the outer maxillipedes.

In the next stage of the development the uropods are free, the telson is, however, still more or less laminar, and the abdominal somites are not provided with pleopods. Seventeen specimens with these characteristics, measuring from 5·0 to 6·6 mm., are present in the collection (Pl. 14. figs. 9, 12, 15, 20, and 21).

The rostrum is relatively shorter than in the previous stage, being about two-thirds to one-half the length of the carapace; the large blunt spine at its base persists, and in one of the specimens two very minute teeth are found in front of it. The blunt tooth in the mid-dorsal line of the carapace near the hinder margin is still present, and a few very minute teeth may usually be seen on the posterior basal edges. The characteristic hump of the 3rd abdominal segment is more pronounced and elbowed than in the earlier stage; a notch is present in the mid-dorsal line of the 4th somite near the posterior edge, and the 6th somite is about three times the length of the 5th. The telson (figs. 20 & 21) is still somewhat foliaceous and is subparallel, or rather wider at the apex than at the base. Distally it is emarginate, and, as in the earlier stage, bears eight pairs of setæ. The uropods are free, the outer in the older specimens bearing a spine on its outer distal edge. The endopod is at first short, but rapidly attains to the same length as the exopods.

The eye (fig. 15) has not kept pace with the growth of the carapace, being now little more than half its length; the cornea is still the widest part. The basal joint of the antennular peduncle is very much longer than the 2nd and 3rd combined; it possesses no lateral process, but is proximally somewhat swollen on its outer edge. The outer flagellum is still quite rudimentary, being little longer than the ultimate peduncular joint; it bears a long apical seta. The inner flagellum has now appeared and is about half the length of the outer; the long seta present in the earlier stage has been carried up on its apex. The antennal scale (fig. 12) is longer than the one-jointed basal segment and reaches to the end of the 2nd joint of the antennular peduncle; it is furnished with numerous long setæ and with a stout spine at its outer distal edge. The long seta which represented the flagellum in the previous stage has disappeared and a short thick protuberance, from one-fifth to one-third the length of the scale, has taken its place.

During the course of this stage the first three pairs of pereiopods with their exopods are developed; in structure they resemble the outer pair of maxillipedes.

All the remaining specimens in the collection, with the exception of two measuring 12·3 and 12·5 mm., belong to the next stage, in which uropods, pleopods, and all five pereiopods are developed, while the eyes remain of relatively large size and are widest across the cornea. These specimens measure from 9·1 to 13·4 mm. (Pl. 14. figs. 10, 13, 16, 22, and 23).

The rostrum is less than half the length of the carapace and is furnished dorsally with

from three to five teeth, the posterior of which, although in some cases small and sharp, appears to represent the blunt spine present in the two preceding stages; ventrally the rostrum is unarmed. The median spine at the posterior edge of the carapace persists, although of comparatively small size, in the larger examples; the minute spinules on the inferior hinder margin of the carapace are present in the smaller specimens only. The elbow on the 3rd abdominal somite is as prominent as in the preceding stage, and the 6th somite is two and a half times the length of the 5th or slightly more. The telson (figs. 22 & 23) is at least three and a half times as long as wide; in younger specimens it is apically emarginate, in older forms more or less truncate. Of the eight original pairs of setæ, two have been carried up the sides of the telson and have become dorso-lateral spinules, others being added during succeeding moults. The apex is thus left provided with six pairs, two of which, the second and fourth counting from the outer angle, are now much stouter and longer than the rest.

The eyes (fig. 16) are still relatively large, one-half the length of the carapace or rather less; as in both the previous stages, the cornea is by far the widest part. The basal joint of the antennular peduncle is proximally much widened on its outer edge, this widened part being produced forwards to an acute point representing the lateral process; this point does not reach forward more than one-third the length of the basal joint. The two flagella in large specimens are about equal and almost as long as the peduncle. The antennal scale (fig. 13) reaches almost to or beyond the end of the antennular peduncle: the flagellum is of varying length, in large examples reaching as far forward as the flagella of the inner antennæ; it possesses two well-marked basal segments. The antennal peduncle is two-jointed.

All the five pereiopods with their exopods have now appeared. Pleurobranchs are present at the base of all five, the arthrobranchs being still rudimentary and represented by buds. Epipods are in evidence at the base of the first three pairs. The legs are all of roughly the same length and are but little longer than their exopods; their respective joints bear much the same proportion to one another as those of the adult, with the exception of the dactylus of the 5th pair, which is as long as that of the 4th. The first two pairs are not chelate and no traces of the spines on the inferior border of the ischium and merus of the last three pairs are yet to be observed.

The two remaining specimens in the collection, of 12·3 and 12·5 mm., represent the post-larval stage to which Coutière has given the name of "*parva*" (Pl. 14. fig. 24; Pl. 15. fig. 1). The smallest specimen of this stage that he found measured only 10·5 mm. It will be seen from the table that some examples in the previous stage attain a length of over 13 mm. This very considerable overlapping of the lengths of the oldest larval and youngest post-larval stages is remarkable, but when the extraordinary variation of the adult is considered it must be admitted that it would be even more remarkable if some sort of variation did not also extend to the development.

By far the most noteworthy feature of the change to the *parva* form is the great reduction of the eye (fig. 17) *. It is now less than one-third the length of the carapace and the cornea is not so wide as the stalk. A rather obscure convex disc situated on the

* Figs. 14, 15, 16, and 17 are drawn to the same scale and show the growth and subsequent reduction of the eye.

upper interior portion of the stalk near the cornea represents the first appearance of the ocular papilla.

The rostrum is now not much more than one-quarter the length of the carapace; dorsally it is armed with from six to eleven teeth; ventrally it is at first unarmed, teeth however, soon appear in the form of nicks in the thin margin. The blunt dorsal spine near the posterior margin of the carapace is still present, but it is still quite rudimentary and shortly disappears. The 6th abdominal somite is less than three times the length of the 5th, and more dorso-lateral spines appear on the telson (fig. 24), the terminal spines of which have all disappeared, with the exception of the two large pairs and one small one which has taken up a central position.

The oral appendages have now assumed a form closely resembling those of the adult, and the first two pairs of pereiopods have, by an outgrowth of the propodus parallel to the dactylus, become possessed of chelæ; these, however, in smaller examples are still quite rudimentary. The ischium and merus of the last three pairs bear a few spines on their inferior border, the full complement being formed subsequently.

The growth of the rostrum and other changes which the *parva* form undergoes before finally attaining its full dimensions have been adequately treated by Coutière (*loc. cit.*).

The most interesting and remarkable feature of the metamorphoses of *A. purpurea* is the reduction and subsequent growth of the cornea and rostrum. In the youngest stages the rostrum is long and is gradually reduced in size until a minimum is reached in the "*parva*" form, from thence onwards it grows with each succeeding moult until the adult form is attained. In old specimens the extreme apex frequently appears to be worn down and is thus to some slight extent again reduced.

The development of the eye is somewhat different; it shows a gradual growth with an increasing number of facets and is widest across the cornea until the "*parva*" form is reached. It is then suddenly diminished in size and the cornea becomes narrower than the eye-stalk; the number of facets has nevertheless very considerably increased. By subsequent growth the eye at length reaches the adult condition with the cornea once more wider than the stalk.

All these young specimens were caught between 100 fathoms and the surface, with the exception of the two referable to the post-larval or "*parva*" form; these were taken between 750 and 500 and between 500 and 400 fathoms respectively *.

The frequent occurrence of the larvæ of this species in the upper strata of the water and the apparent absence in that horizon of the post-larval forms seem to suggest that at the approach of the "*parva*" stage the animals descend to what is probably the normal

* [Treated as in earlier papers of this series, these larvæ

were taken at	fathoms in	per cent. hauls, with	average specimens per hour haul.
0	0	0	
25	25	0·5	
50	69	1·8	
75	27	0·5	
100	40	0·5	

Both sets of figures point to 50 fathoms being the preferred horizon; but the total numbers are unfortunately small.—G. H. F.]

level of the adult. The evidence is, of course, far from conclusive and other records of the post-larval forms throw no light on the subject. Coutière's specimens were caught in vertical nets at two stations, the hauls being 1000 m. to the surface and 3250 m. to the surface; those taken by the 'Helga' off the Irish coast were captured in a mid-water otter-trawl, which was lowered to about 350 fathoms, the net fishing while being hauled to the surface.

Even in the case of the adult, a Macruran of almost world-wide distribution, but little is known of the bathymetric range. The adult male present in this collection was caught between 100 fathoms and the surface, a young male was caught off the American coast actually on the surface, while the species has been trawled between 107 and 2949 fathoms. The probability, in the latter case, that the specimen was caught during the ascent of the net renders it and similar records almost worthless from a bathymetric point of view. The solution of the problem is to be sought either in successive hauls to the surface from varying depths of wide-mouthed vertical nets, or, more certainly, by the use of a self-closing net of very large dimensions.

Acanthephyra debilis, A. Milne-Edwards.

A mature male, 67 mm. in length, was caught in haul 30 *m*, between 25 fathoms and the surface. The basal crest of the rostrum bears four teeth, the rostrum itself being furnished with twelve teeth above and eight below.

The specimen, which is preserved in formalin, has retained a considerable amount of the deep scarlet-red pigment so frequently met with among deep-sea Macrura, and the numerous luminous spots and streaks so fully described by Coutière (Bull. Mus. Oceanogr. Monaco, No. 70, 1906) are well shown. The distribution of the red pigment in connection with these presents features of some interest. Over each photophore is seen a small clear area, quite devoid of pigment, forming as it were a small window to allow of the passage of light outwards. These transparent are areas of similar shape to the photogenic spots over which they are placed; over single round photophores they are round, over the prominent vertical luminous organ which is situated behind the 5th pair of thoracic legs there is a quite large elliptical area, while a narrow transparent line is to be seen over the row of closely approximated photophores along the anterior basal edge of the carapace.

A. debilis is apparently a somewhat rare species and has been recorded from depths of 350 to 2512 fathoms. These captures were made with open nets and are consequently of little value for the determination of the bathymetric range; still it seems certain that the present specimen was far above its normal horizon.

The occasional appearance at the surface of species normally frequenting deep water is a phenomenon of considerable interest. It has been suggested that the females rise to the surface to liberate their eggs in order that the larvæ may have warmer water in which to undergo their metamorphoses and a better chance of distribution by means of ocean-currents. In the present species, however, the young leave the egg more fully developed than is the case with *A. purpurea*, presumably that they may be enabled to survive under conditions which would prove fatal to a zoæa.

Hymenodora glacialis (Buchholz) ?

Macerated fragments from haul 26 *b*, 2000–1500 fethoms, may almost certainly be referred to this species. If correctly determined, the record marks the most southern limit in the known distribution of the species.

Unknown larva allied to Caricyphus, Spence Bate. (Pl. 15. figs. 2–8.)

The whole animal is strongly laterally compressed; the rostrum unarmed and slender and about two-thirds the length of the carapace. The carapace itself is more than three times as long as deep, carinate on its anterior third and furnished with a blunt spinule behind the orbital notch; it is extended as an acute point above the insertion of the antennæ and the anterior basal edge is marked by a short slender spine.

The last four abdominal somites are dorsally carinate, the 3rd is very pronouncedly elbowed, the segment extending to an acute hump, forming a most prominent feature in side view; the 6th somite is rather more than two and a half times the length of the 5th. The telson (fig. 8) is almost twice the length of the 6th somite, apically it is rather broad, somewhat truncate, and furnished with five pairs of spines, the second pair counting from the outer edge being very much longer than the rest. Laterally it bears five or six pairs of spinules.

The eye is not one-third the length of the carapace; the cornea is very large, somewhat elliptical, and set obliquely on the stalk. The basal joint of the inner antennæ reaches to the distal extremity of the eye; proximally the segment is laterally expanded and in larger specimens there is a small acute point projecting forwards forming the first beginnings of the lateral process. On the inner side of the joint at about its middle are set three rather long forwardly directed spines. The 2nd joint is somewhat longer than the 3rd and the outer flagellum is at its base considerably stouter than the inner. The antennal scale reaches slightly beyond the peduncle of the inner antennæ; it is narrow and bears the usual spine at its outer distal edge.

The mandibles (fig. 3) show both molar and cutting edges, the latter being furnished with three strong teeth. In the first maxillæ (fig. 4) the basal lobe is broad and bears many setæ, the upper lobe being narrower and provided with stiff bristles. The endopod is one-jointed and is furnished apically with three stout setæ, while from a tubercle on the inner side two others arise. The basal portion of the second maxilla (fig. 5) is internally trilobed and setiferous; the endopod is short, one-jointed, and bears apically five or six setæ, while two or three others are situated on two prominences on the inner aspect. The exopod is long and narrow, externally it is slightly concave; the anterior lobe projects forward about twice the length of the endopod, the narrow posterior lobe being about half its length. The margin is uniformly clothed with fine setæ.

Both basal joints of the first maxillipede (fig. 6) are broad, the second being densely clothed with setæ on its inner edge; the endopod is three-jointed and bears few setæ. The exopod is slender, about three times the length of the endopod; it is divided distally into several annulations. The epipod is bilobed, the lower lobe being the larger. The second maxillipedes (fig. 7) possess a five-jointed endopod, an exopod which is slightly shorter

and very slender, and a large epipod. A small leaf-like extrusion at the base of the epipod may represent the first appearance of a podobranchia.

The third maxillipedes and first four pereiopods are provided with long setose exopods. The fifth pair are much shorter and possess no exopods. None of the legs show any signs of chelæ and the dactyli in all of them are minute. Short pleopods are present in specimens measuring 23 to 25 mm., in a specimen of about 15 mm. they are quite rudimentary.

Four specimens of this larva measuring from 15 to 25 mm. are present in the collection. Two were caught between 50 fathoms and the surface and two between 100 fathoms and the surface (21 *d*).

Although in general aspect this larva bears some resemblance to young *A. purpurea*, the absence of an exopod on the last pereiopod proves there is no close affinity between them. They closely resemble certain of the immature forms described by Spence Bate (Chall. Rep. 1888) under the name of *Caricyphus*, which have since been considered to be larval Hippolytidæ; it is, however, probable that young individuals of several genera are included under this name.

ANOMURA.

A Pagurid metazoæa was caught between 100 fathoms and the surface; the specimen is unfortunately dry.

Two other Anomurous larvæ were caught between 75 fathoms and the surface: numerous specimens of this larva and of some of its later stages have been met with off the Irish coast; it therefore seems best to defer any account of it until opportunity occurs of dealing with this more abundant material.

BRACHYURA.

Three metazoææ were caught between 50, 75, and 100 fathoms and the surface and four megalopæ occurred at the same depths.

Additional Note.

Since the above was written, a specimen of *Acanthephyra debilis*, only 10·2 mm. in length, has been found off the W. coast of Ireland. This specimen, which possesses only six pairs of photophores, is very different from that figured by Coutière as the form in which the species leaves the egg. The rostrum is scarcely longer than the eyes, the pleopods are short and bud-like, no uropods are developed, and the telson is broad, rounded, and apically emarginate, as in young *A. purpurea*. All the pereiopods are developed, and a bud at the base of each represents the first appearance of a pleurobranch.

Although the discovery of this specimen shows that the differences between the earliest forms of *A. purpurea* and *A. debilis* are less than was previously thought, there is still evidence to show that the *A. debilis* larva is much the more advanced of the two, for all its pereiopods are formed and the pleopods, although rudimentary, are not totally undeveloped.

[*September* 1907.]

EXPLANATION OF THE PLATES.

Plate 14.

Acanthephyra purpurea, A. M.-Edw.

Fig. 1. Zoæa measuring 4·3 mm. side view, right eye removed.
2. Antennule of zoæa.
3. Mandible of zoæa.
4. First maxilla of zoæa.
5. Second maxilla of zoæa.
6. First maxillipede of zoæa.
7. Second maxillipede of zoæa.
8. Third maxillipede of zoæa.
9. Larva measuring 6 mm.; side view.
10. Larva measuring 10·4 mm.; side view.
11. Antennæ of zoæa.
12. Antennæ of larva measuring 6 mm.
13. Antennæ of larva measuring 10·4 mm.
14. Eye of zoæa.
15. Eye of larva measuring 6 mm.
16. Eye of larva measuring 10·4 mm.
17. Eye of post-larval or "*parva*" form.

} Drawn to the same scale.

18–24. Development of telson and uropods: fig. 18, telson of zoæa; fig. 24, telson of "*parva*" form.

Plate 15.

Fig. 1. *Acanthephyra purpurea*, A. M.-Edw., post-larval or "*parva*" form.

Larva allied to *Caricyphus*, Spence Bate.

Fig. 2. Side view of a specimen measuring 22 mm.
3. Mandible.
4. First maxilla.
5. Second maxilla.
6. First maxillipede.
7. Second maxillipede.
8. Telson.

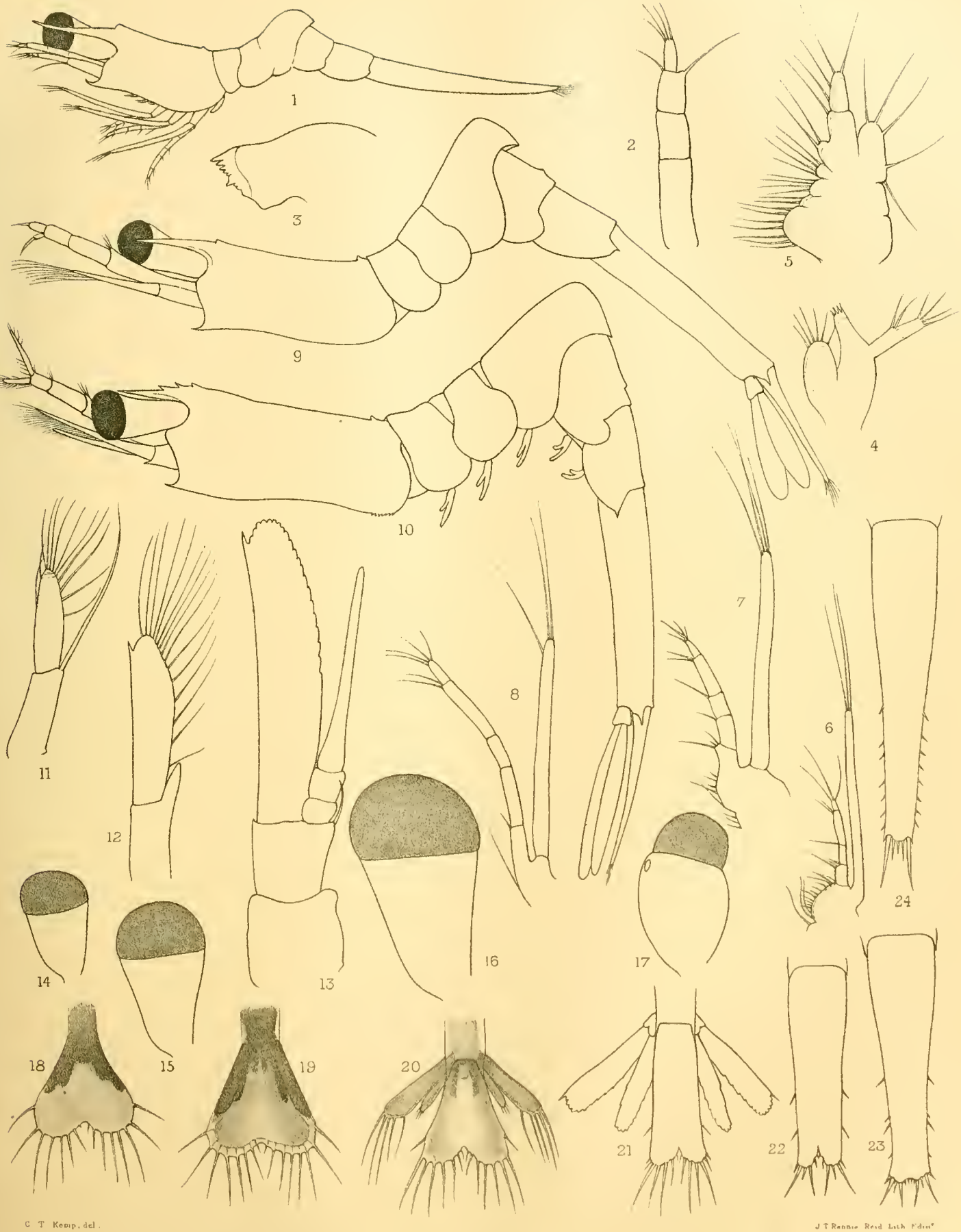
NOTE ON DISTRIBUTION.

By G. Herbert Fowler, *Ph.D., F.L.S.*

In the following table of "comparable hauls," in the column headed *Acanthephyra purpurea*, A = adult, P = "*parva*"-stage.

Depth in fathoms.	Haul.	*Amalopenæus elegans.*	*Serycstes arcticus.*	Larval Sergestidæ.	*Acanthephyra purpurea.*	*Acanthephyra debilis.*	*Hymenodora glacialis.*	*Caricyphus.*	Larval Anomura.	Larval Brachyura.
500—250	29 *a*									
1500—750	30 *a*									
2000—1000	30 *e*									
0	21 *e*									
	21 *f*									
	21 *i*	..	2							
	22 *d*	..	..	1						
	22 *e*									
	22 *g*	..	2							
	23 *b*									
	23 *c*									
	23 *d*									
	23 *e*									
	24 *c*									
	24 *f*									
	24 *g*									
	24 *h*									
	24 *i*									
	24 *k*									
	25 *a*									
	25 *b*									
	25 *h*									
	25 *i*									
	25 *l*									
	30 *c*									
	32 *c*									
	33 *a*									
	33 *b*									
25—0	26 *a*	..	..	1	4					
	30 *b*	..	..	2						
	30 *m*	..	..	..	..	1				
	31 *a*									
	32 *b*									
	32 *e*									
	33 *e*	..	1							
	33 *g*	..	..	..	1					
	34 *a*									
	34 *g*	..	..	..	1					
	35 *w*									
	36 *c*									
50—0	21 *g*									
	25 *e*									
	25 *g*	..	..	..	3					
	25 *k*	..	..	..	1					
	26 *c*	..	..	..	1					
	30 *d*	..	..	7						
	30 *l*	..	1	2	13					
	31 *b*	..	2	3	1					
	32 *a*	..	..	..	2					
	32 *h*	..	..	..	1					
	33 *c*	..	..	..	1					
	33 *f*	..	1	..	1					
	36 *d*									
75—0	30 *f*	..	..	4	2					
	32 *g*									
	32 *m*	..	..	..	3	..	..	..	1	
	32 *o*	..	..	..	1	..	..	..	1	
	33 *h*	..	..	..	..	..	..	..	..	1
	34 *c*	..	..	1	..	..	..	..	1	
	35 *a*									
	35 *c*	..	6	2						
	35 *e*									
	35 *y*	..	1							
	36 *a*									

Depth in fathoms.	Haul.	*Amalopeneus elegans.*	*Sergestes arcticus.*	Larval Sergestidæ.	*Acanthephyra purpurea.*	*Acanthephyra debilis.*	*Hymenodora glacialis.*	*Coriophus.*	Larval Anomura.	Larval Brachyura.
100—0	21 *h*									
	21 *l*									
	22 *a*	..	..	..	1					
	24 *b*	..	1	..	..	..	..	1		
	24 *d*									
	24 *e*									
	25 *d*	..	..	..	1	..	..	..	1	
	30 *g*	..	..	..	1	..	..	1		
	30 *h*									
	32 *d*	..	..	..	..	..	..	..	..	1
	32 *i*									
	32 *u*									
	32 *p*	..	..	2	2					
	33 *d*									
	34 *b*	..	..	..	1					
	34 *d*	..	..	..	1					
	35 *b*	..	1							
	35 *d*	..	..	..	1					
	35 *f*									
	35 *x*									
	36 *b*	..	..	..	3+1 A					
	36 *e*	..	..	..	1					
150—0	36 *f*	..	..	..	1					
150—50	21 *p*									
150—100	21 *n*									
200—0	21 *a*									
	36 *g*	..	..	..	1					
200—100	21 *b*									
	21 *o*									
	26 *e*	..	?							
	34 *h*									
	35 *m*									
	35 *n*									
	35 *l*									
250—0	36 *h*									
	36 *i*									
250—150	35 *o*									
	35 *p*									
	35 *s*									
300—0	36 *k*									
300—200	21 *c*									
	26 *f*									
	35 *t*									
350—0	36 *l*	1								
400—300	21 *k*									
	32 *l*									
	35 *k*									
500—400	21 *m*	..	?	..	1 P					
	35 *h*									
	35 *i*	?								
750—500	22 *b*									
	30 *k*									
	34 *e*									
	34 *f*	..	..	..	1 P					
1000—750	23 *a*									
	27 *c*									
	31 *d*									
	32 *f*									
	32 *k*									
1250—1000	24 *a*									
	27 *b*									
	31 *c*									
1500—1250	25 *f*									
	30 *i*									
2000—1500	25 *c*									
	26 *b*	..	..	..	..	..	?			



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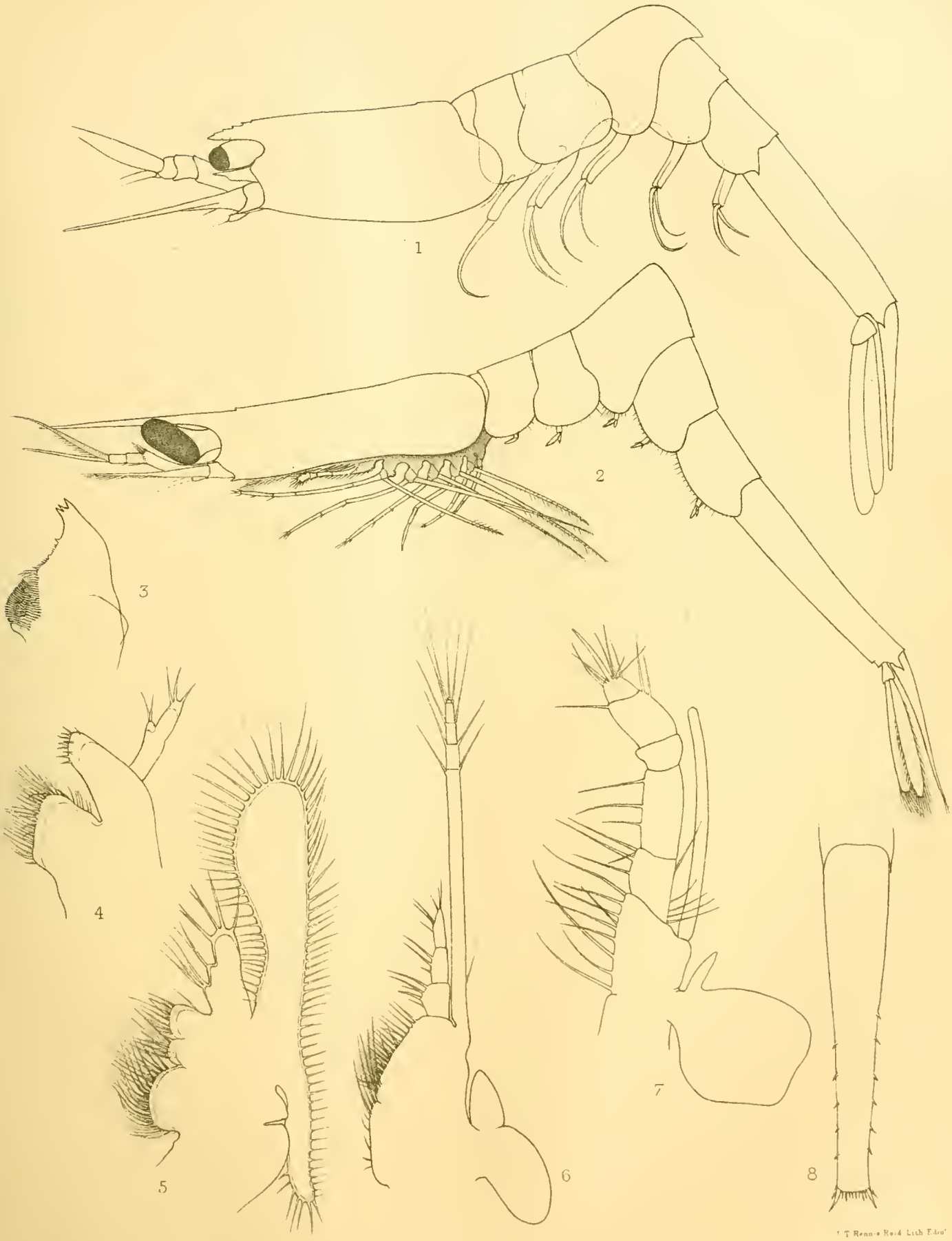
DECAPODA FROM BISCAYAN PLANKTON.



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DECAPODA FROM BISCAYAN PLANKTON

BISCAYAN PLANKTON.

Part XII.—The OSTRACODA.

By G. Herbert Fowler, *B.A., Ph.D., F.L.S.*

(Plates 16–27.)

Read 3rd December, 1908.

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I. INTRODUCTION.

The study of the Ostracoda collected during the 1900 cruise of H.M.S. 'Research' proved to be an arduous undertaking. More than 7000 specimens have been identified; and in more than 3300 specimens the sex has been determined and the antero-posterior length of the shell measured. The results are such that one need not grudge the time and labour involved, for the neglected little family of Halocypridæ, by the number of its members and by its presence at (apparently) all depths, affords admirable material for the study of oceanic problems. Thanks to the labours of Professor C. W. Müller, of Greifswald, the species are now more or less orderly arranged, and the difficulties of manipulation are only serious in the case of the minuter specimens of less than one millimetre.

Comparable and Non-comparable Hauls.

The comparable hauls of Ostracoda in the epiplankton were only 65. All hauls with nets of 18 or 180 meshes to the linear inch were omitted: the former allow small specimens to slip through; as regards the very fine-meshed nets, it has become clear in the course of the study of the Biscayan material that they are perfectly useless for a proper representation of the macroplankton, presumably because the frictional resistance of the meshes is so high, that such nets simply push the water in front of them aside and allow very little to filter through them. A few more of the hauls have been rejected because the material had been allowed to dry, because part of the catch had been lost, &c.

Of the serial hauls 36 *e* to 36 *l*, the deepest (36 *l*) has been completely worked out for specimens over 1 mm. in length; of the other non-comparable hauls only 27 *a* (1250–0 fms.) has been completely worked out. There are limits to human patience, and mine had been already reached when 36 *d* was finished. In some cases, however, of the rarer species, the non-comparable hauls have been gone over roughly in order to get more specimens for measurement; these specimens appear in the tables of lengths, but not in those of distribution.

Manipulation.

The chief difficulties with an Ostracod are to hold the little bi-convex shells steadily for dissection, and to get them exactly into a horizontal position for drawing and measurement. The tools needful are a pair of mounted needles, the one blunt, the other as sharp as constant grinding will keep it; and a microscope slide in which a convex hollow has been ground, such as is used as a "cell" for mounting thick objects.

The first thing is to get the specimen (if unfamiliar) into the right horizontal position for observing and drawing its contour: it is put into the hollowed slide, and all superfluous fluid removed with a fine glass pipette; this method is most useful, because the remaining film of fluid tends to hold the animal steady by surface-tension. The animal is then pushed up the side of the cell, the curve of the hollow being utilised to tilt it into exactly the right position with certainty. In the case of nearly spherical forms, such as *globosa* ♀, the animal can be supported by two fine threads of drawn glass in the required position. The shape of the shell, which can now be accurately observed, yields on the whole the most satisfactory specific character, and generally points to one of at most some half-dozen of species. As far as possible, the contour should always be studied and drawn before dissection; the contour should never (if avoidable) be drawn from inside with the shells opened out flat, as this procedure produces distortion near the hinge (dorsal border). The openings of the asymmetrical glands should then be considered (the opening of the left gland of *rotundata* can rarely be seen except from the left side with the specimen strongly tilted ventrally).

After this, it is generally necessary to open the shells. Again utilising the surface-tension of a thin film of water, the animal should be put on its back and held with the blunt needle, the sharp needle inserted, first between the shells, and then between the left shell and the body, until it is possible to make a cut with it through the occlusor muscles: the left shell can then be hinged back, cutting with the needle through the internal lining membrane if tough. Holding the animal with the blunt needle about the middle of the body, cut with the sharp one round the base of the large muscle of the second antenna; this appendage can then be hinged back, without being absolutely detached. All the

important organs required for specific identification (thanks to Müller's investigations) are then exposed to view; and the frontal organ should be drawn *in situ*, to ensure a true profile. When the specimen has been identified, the left antenna ii can be pushed back into position and the shells closed; the specimen is none the worse for the operation. For the determination of sex it is better to turn back the left shell than the right, as the penis lies on the left side. In the youngest stages, however, this organ is represented only by two rudimentary buds, and it is not always possible to make sure of its presence or absence; nor can the appearance of the immature generative gland be relied on to settle the sex; in such cases the characters of the flagella and sense-tubes of the first antenna generally give a clue, except in the very youngest stages.

The measurements of the shell-length have been taken whenever possible from the inner aspect of the right shell with the left shell turned back, as this is the less likely to be distorted by the dissection. They were taken with Zeiss micrometer ocular 3, in combination with objectives a^2, a^3 (with tube at 0 or at 21 mm.), and A; the value in μ of 20–60 divisions of the ocular micrometer, for each objective and stand used, having been determined by a stage micrometer. *The measurement was made parallel to the dorsal border from the most prominent part of the anterior border, ventral to the niche for the second antenna**.

Appendages should always be drawn in the preserving fluid (formalin or alcohol) and before mounting, in order to get full advantage of differences in the refractive index, when dealing with fine hairs or teeth. If it is desired to mount appendages permanently for reference, Farrant's solution "ringed" with gold-size may be recommended.

No one knows better than the writer that the present memoir is full of unproven assumptions and of arguments in a circle; for these he offers no apology. There is no harm in such assumptions so long as it is made clear to the Reader where fact ceases and hypothesis begins, and so long as the evidence which has suggested the assumptions is put fairly before him for his private judgment.

It seems to me quite certain that we shall make no advance in serious oceanic planktology† by the methods (or rather, lack of methods) which have hitherto prevailed. No amount of hauls with vertical open nets, no number of handsome Reports on barren systematic morphology, will further our grasp of this branch of Natural History. If my assumptions do but stimulate some one to go to sea in order to disprove them (criticism ashore is too facile) they will have served their turn, be they right or wrong.

In his great work on the Ostracoda of the 'Valdivia' Expedition, Dr. Müller ‡ brought out the fact that the contour of the shells, the position of their glands, and the characters of the cephalic appendages (frontal organ, antenna i, antenna ii) are usually sufficient for the recognition of the species. But, unfortunately, except for the shell-contour, the characters which he gives apply only to sexual stages, and are useless for immature

* This gives a real measurement of the shell, which is comparable in different species. Some previous observers have measured the length from the tip of rostrum to tip of posterior spine, thus obtaining measurements which are not expressions of the general body-length.

† Neritic planktology with economic aims is on a different footing.

‡ 'Wissenschaftliche Ergebnisse der deutschen Tiefsee Expedition auf dem Dampfer Valdivia,' 1898–1899, vii. 2. C. W. Müller: Ostracoda. Jena, 1906. In the following pages, where "Müller" alone is mentioned without citation, the reference is to this work.

specimens. The further that we go back in the ontogeny, the more do the organs in question resemble one another; even the shell-contours of different species tend to converge towards a common and, presumably, ancestral type. Dr. Müller made no attempt to define the characters of the early stages, although they can hardly fail to have been present in large numbers in the collection.

In handling large collections from tropical or subtropical waters (such as those in which the 'Valdivia' very largely worked), owing to the great number of species present in a haul and to the scattered nature of the stations, it is far more difficult to make due allowance for such perturbing factors as variation, developmental changes, and sexual dimorphism, than is the case in temperate or sub-polar waters; for in these latter the large number of specimens but a comparative paucity of species are more characteristic. In other words, the argument, that two very similar forms (whether male and female, or larva and adult) are likely to belong to the same species because they are constantly associated together in the collections, is far stronger in temperate than in tropical seas. Probably all who have worked over large plankton collections from temperate waters will agree, that very closely allied species—species studied in the detail which has become necessary in such groups as Copepods, where a few hairs more or less may turn the scale—are rarely found together at the same horizon (sea-climate) *. In tropic waters this is apparently not so marked. Too much stress must not be laid on what may be called "the argument from constant association," but it is no doubt of considerable value in dealing with southern or northern collections such as the present.

Again, the purely local nature of the present collection is a great help; in the comparatively scattered collections of the 'Valdivia,' which probably met a fresh combination of species into the fauna at nearly every station, it would have been almost impossible to have worked out the relations of larvæ and adults; in the small area studied by the 'Research,' where the general combination of species to form the local fauna hardly varied from day to day, it is far easier to connect together successive stages of the same species.

Consequently an attempt has been made in this Report to link up larvæ and adults wherever practicable. Until this has been done, it is dangerous to use Ostracoda as counters in a discussion of problems of oceanic distribution. For, although the younger stages of many organisms appear to react to their environment in a manner different from their adults, still this cannot be taken for granted in every case without proof.

As in the case of some other groups already described, I have tried to sort out from the general collection every specimen of an Ostracod captured. With the minute specimens of less than 1 mm. in total length, this is of course really impracticable. But, as I have already pointed out (pp. 7, 93), the error will merely underestimate the difference between abundance and scarcity, and is therefore an error on the safer side.

The difficulty in connecting immature larvæ with their sexual adults in Ostracods and other Crustacea, lies in the alteration of the form of the shell and appendages at each

* An apparent instance, however, will be found below in *Conchœcia magna* and *zetesios* (p. 310).

successive moult (or at least each growth-moult). Fortunately, the shell-contour in Halocypridæ does not alter so much as the principal organs: it does alter somewhat in most of the species studied below, but more gradually and to a less extent than do the cephalic appendages adopted by Dr. Müller for diagnosis.

Something more, however, than a general resemblance of shell-contour is necessary in order to link up securely older and younger stages of a species. The clue, which for some time I sought in vain, is to be found in an observation of W. K. Brooks*. He noticed, in four specimens of Stomatopod larvæ captured at St. Vincent, a curious mathematical relation: that if the length of the shortest larva, 4·16 mm., be multiplied by $\frac{5}{4}$, and the product by $\frac{5}{4}$, and so on, the following numbers are arrived at:—5·20, 6·50, 8·13, and 10·16 mm.; and his other three larvæ were actually 5·29, 6·49, and 10·21 mm., the 8·13 stage not having been captured.

I have developed this relation for Halocypridæ in the following pages, and propose that it should be termed "Brooks's law," in honour of one of the most ingenious of recent naturalists. If it prove to be true in other Crustacea (as I expect, having tested it in a Macruran and a Brachyuran), it could be phrased as follows:—"During early growth, each stage increases at each moult by a fixed percentage of its length, which is approximately constant for the species and sex." In Halocypridæ this percentage differs in males and females, as the egg is presumably of the same size in both sexes, but the males are ultimately shorter than the females of the same stage in nearly every species and group.

I am well aware that a great many more instances must be recorded before this proposed "law" can be accepted, even with probable modifications, but I have overemphasized it in order to call the attention of students to the necessity for testing it wherever possible. If it proves to be general, it will be of great value to the planktologist, as helping him to connect the swarms of larvæ in a neritic haul with each other and with their adults.

It will carry more conviction, if one takes for the first illustration a species with a quite unmistakable shell-contour such as *Conchœcia imbricata* (figs. 110–121, Pl. 20). Of this species only a few specimens were captured, but by selecting *imbricata*, though the mathematical completeness is less, the zoological certainty is greater; and it will serve as well as any other species to demonstrate the simple mathematical methods employed.

When all available specimens of *imbricata* had been measured and sexed, they formed the following series: the number of specimens in each sex at each length being placed opposite to that length.

* Report H.M.S. 'Challenger': Zoology, xvi. The Stomatopoda, p. 105.

♀.	mm.	♂.
Stage II. Mean, 2·34 mm.: 3	2·5	
7	2·4	
12	2·3	
1	2·2	
1	2·1	2 — Stage II.
	2·0	5 — Stage II.
	1·9	1 — Stage II. Mean, 2·01 mm.
	1·8	
	1·7	1 — Stage III.
Stage III. Mean, 1·50 mm.: 2	·6	1 — Stage III.
17	1·5	7 — Stage III. Mean, 1·48 mm.
2	1·4	5 — Stage III.
	1·3	
	1·2	
	1·1	
Stage IV. Mean, 0·96 mm.: 11	1·0	14 — Stage IV. Mean, 1·0 mm.
6	0·9	
	0·8	
Stage V. Mean, 0·66 mm.: 2	0·7	
1	0·6	

Table A.—Total specimens measured: 65 ♀ + 36 ♂ = 101.

It will be noted that the total numbers are very small in both sexes, but higher totals are available in some other species.

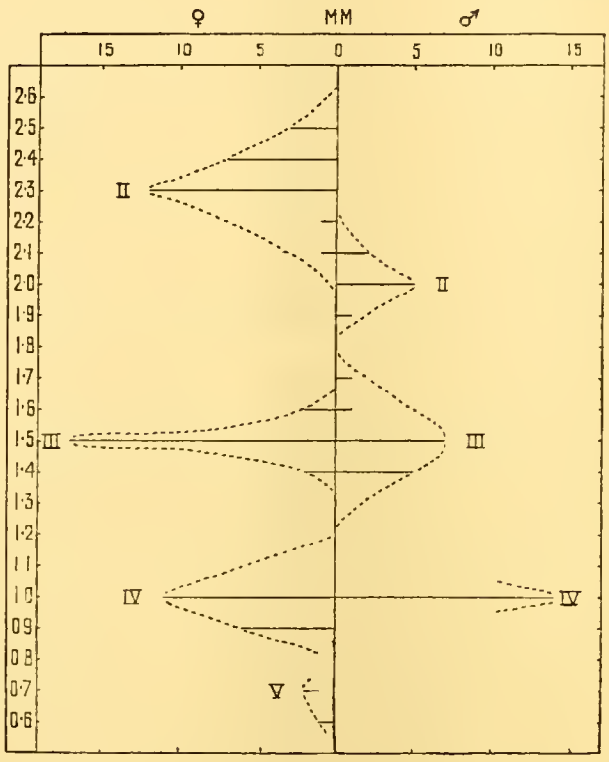
Now, taking the mean lengths of the females at the different stages:—0·62×1·56= 0·96; 0·96×1·56=1·497 (mean 1·50); 1·50×1·56=2·34,—that is to say, the mean length of the shells at each stage when multiplied by (what we may call) the growth-factor 1·56 * yields approximately the mean of the next oldest stage. The males are much fewer and therefore respond less accurately:—1·0×1·45=1·4; 1·4×1·45=2·03. In other words, at each of the growth-moults, the shells of the females increase by some 56 per centum of their length, and those of the males by some 45 per centum. The decimals would no doubt require alteration (especially in the males) if more specimens were available; as already said, the case of *imbricata* is less conclusive mathematically than zoologically. Even in species more plentifully available it is hardly possible to get the second place of decimals in the observed mean to coincide precisely with that in the mean calculated from the growth-factor; the reason being that it is impossible to measure these little biconvex and delicate shells with any pretence at accuracy to a hundredth of a millimetre, which is the second place of decimals in this instance.

The observed lengths and their frequency have been plotted on scale-paper in the accompanying diagram (fig. A, p. 226). The abscissa represents a millimetre-scale from 0·5 to 2·7 mm.; the ordinates on the left of this represent the observed numbers of females, the ordinates on its right those of the males. Even with the small total

* Determined empirically on a slide-rule.

number available, the tendency of the ordinates to form a curve of frequency at each stage is noticeable, though the shape and area of the curve is entirely guesswork in the present instance *. When the numbers are greater, and a greater range of variation is found in each curve, the extremes of the curve may respond to the same growth-factor as the means. Even here, in the more numerous females, $0{\cdot}6\times1{\cdot}50=0{\cdot}9$; $0{\cdot}9\times1{\cdot}56=1{\cdot}4$; $1{\cdot}4\times1{\cdot}56=2{\cdot}1$, that is to say, the shortest observed length at each stage multiplied by the growth-factor gives the shortest at the next stage: and $0{\cdot}7\times1{\cdot}56=1{\cdot}0$; $1{\cdot}0\times1{\cdot}56=1{\cdot}56$ (1·6); $1{\cdot}6\times1{\cdot}56=2{\cdot}49$ (2·5), that is to say, the same is approximately true for the greatest length at each stage.

Fig. A.



Literature.—A list of the most important memoirs was given in Professor Müller's 'Valdivia' Report. Two have appeared since that date: V. Vavrá, 'Die Ostracoden der Plankton Expedition, 1906'; and C. Juday, "Ostracoda of the San Diego Region," Univ. Calif. Public., Zool. vol. iii. no. 2, pp. 13–38 (1906), as well as Müller's own Reports on the Ostracoda of the 'Siboga' and 'Belgica' expeditions.

* In this explanatory instance of *imbricata* alone, an imaginary curve of frequency has been drawn over the ordinates. In subsequent diagrams of other species, the ends of the ordinates have been connected by dotted straight lines, rather in order to show which of them can be grouped together as belonging to the same stage, than with any mathematical meaning.

II. SYSTEMATIC PART.

In Halocypridæ, as in nearly every group of Crustacea, we owe the main lines of morphological and taxonomic study to the late Professor Claus. With only a few specimens of comparatively few species at his disposal, chiefly from material obtained by Professor Chun at the Canary Islands, he produced in 1891 (after two pioneer papers) the important monograph 'Die Halocypriden,' which showed the variety and interest of this family. Whether the wide systematic distinctions to which he called attention are to be utilised to divide "genera" (as Claus did) or "groups" (which Dr. Müller prefers), does not seem to be very important. This monograph was accepted by all intermediate writers till 1906, when Professor Müller's Report on the Ostracoda of the 'Valdivia' Expedition appeared; this has added enormously to our systematic knowledge, and will remain the standard for some time to come; the taxonomy and synonymy therein laid down have been accepted in the present memoir.

The descriptions and figures in this part are intended merely to be supplementary to those in Müller's 'Valdivia' Report. Where they overlap, the object is to supply ready material for comparison of the different stages of the same species.

Of these stages, that which is believed to be the oldest is termed Stage I., it being in all cases, at present, uncertain at which morphological stage or length the larva is hatched. As it is easiest to pass from the known to the unknown, the oldest stage available has been made the starting-point in all descriptions.

Dr. Müller's synonymy and grouping have been adopted, except for the fact that some of his species have been placed as stages in the life-history of species already known: this suggested linking of "species" is shown in the following table:—

	Previous Name.	
Name of Species.	Stage II.	Stage I.
curta	curta.	stigmatica.
daphnoides	daphnoides, var. minor = lacerta.	daphnoides, var. major.
hyalophyllum	hyalophyllum.	lophura.
loricata	loricata.	ctenophora.
magna	magna.	macrocheira.
procera	procera.	decipiens.
spinirostris	spinirostris.	porrecta.

The mean length in mm. of each sex at each stage, when possible, is given thus (Mean, 0·00), and is based solely on my own observations. To have included the lengths given in previous records might have led to error, as taking for granted that the mean of a stage is the same at every geographical position and sea-climate; this is probably not

the case *. For example, Müller notes under many species that the Antarctic specimens were larger on the whole than those from the tropical and temperate regions traversed by the 'Valdivia.' Again, not all observers measure the same "length": Dr. Müller seems to have included the rostrum, and a spine when present.

For diagnostic characters I have followed Müller's admirable selection as far as possible, except in the case of the shell-sculpture. In formalin specimens of most of the species which I have seen, the sculpture is often so difficult to make out (as, indeed, Dr. Müller himself admits), that it can only be regarded as a secondary diagnostic character at best. Of two specimens of the same length and the same species from the same haul, it may be conspicuous in the one, nearly invisible in the other.

As regards the various glands, for the diagnostic value of which we are indebted to Müller, a little caution is necessary. They were by no means always so obvious in my formalin material as they appear to have been in the 'Valdivia' collections. Some experiments in staining seemed to show that the obviousness of the glands when unstained varied very much, and presumably depended upon their physiological condition (secreting or discharged) at the moment of death.

If it is desired to stain formalin specimens for the glands, the following method will be found useful:—To a (7 per cent.) store solution of formalin add 5 per cent. of Delafield's hæmatoxylin ; the mixture should be made fresh daily, and filtered. After immersion in this for about twenty minutes, the apertures of the gland-cells will be found deeply stained, the cell-walls slightly stained; the asymmetrical glands assume a brownish-yellow tint.

As with other smaller members of the macroplankton (excepting *Ctenophora*), formalin is the best reagent both for killing and storing. Mercury bichloride is detestable, rendering the tissues opaque and unyielding, and covering the specimens with a dust of apparently insoluble mercuric compounds. Alcohol leaves the specimens clean, but equally opaque and resistent. Pieric acid did not seem to have any special value.

HALOCYPRIDÆ.

The species of *Conchœcia* in this memoir have been arranged in alphabetical order for convenience of reference. The following table shows their distribution according to the groups recognized by Dr. Müller:—

Group of	Species.
spinifera	spinifera.
	inermis.
elegans	elegans.
procera	procera=decipiens.
	brachyaskos.

* In this connection *Conchœcia* would form an interesting test-case of the suggestion which has been put forward, that polar, sub-polar, and deep-water forms—that is, cold-water forms—owing to a less rapid metabolism, live longer, become sexual later, and grow larger, than forms of the same species in tropical waters.

Group of	Species.
rotundata	rotundata.
	pusilla, var. major.
curta	curta = stigmatica.
bispinosa	Haddoni.
loricata	loricata = ctenophora.
magna	magna = macrocheira.
	hyalophyllum = lophura.
	spinirostris = porrecta.
	zetesios, sp. n.
mollis	kampta.
	tyloda.
	rhynchena.
imbricata	imbricata.
	ametra.
daphnoides	daphnoides = lacerta.

Only four of Müller's fifteen groups were not represented, those of *dentata*, *acuminata*, *obtusata*, and *alata*.

Conchœcia ametra, Müller.
(Plate 16. figs. 1–19.)

The sizes of this species were given by Müller (p. 118) as: ♀ 4·1–4·6, ♂ 3·7–4·1. Measurement of his figure shows that he included the rostrum and posterior spine in these lengths; this figure, measured in the manner adopted in the present memoir, gives a length of 3·5 for the female; his specimens were therefore at the same stage as my longest specimen, as also apparently were those of Vavrá and Juday. There is probably an older stage not yet captured, since the next lowest stage (mean 2·16) had not developed secondary male sexual characters.

Stage II.

Male (Mean 3·10).—Shell elongate; the height about half the length; with a marked shoulder-ridge. The dorsal border of both shells terminates posteriorly in a single spine, the left being longer than the right; the posterior border begins nearly at right angles to the dorsal border; the postero-ventral angle rounded off. The ventral border is slightly arcuate, and does not begin to taper till well in front of the middle of the length; the shell is about equally high in front of and behind the arcuation. Rostra of the general type of the *imbricata*-group, but shorter than in *imbricata*; they are asymmetrical, the left being longer than the right. A papilla which carries the openings of the glands of the right side is large, and projects markedly beyond the shell-outline; that of the left side is small, and projects little or not at all. Sculpture of the shell strongly marked, agreeing with that of *ametra*. Frontal organ with only a small part of the stem projecting beyond the antenna. Terminal joint proximally much

thicker than the stem; diminishing towards the apex, constricted and bent upwards before the middle of its length; carrying five or six long spines on its dorsal border, numerous short spines on the proximal two-thirds of its ventral border. Antenna i.: the principal bristle carries about 33 pairs of foliate appendages (as in *ametra*), backwardly directed, diverging widely when both rows are seen from above them; in front of them are three or four short upright spines. A small pad (*Schwiele*) occurs on the proximal accessory bristle; hairs of the terminal bristles, if present, exceedingly minute. Antenna ii. with two central bristles on the inner limb, the one about two-thirds of the length of the other: the basal bristles more widely apart than usual, the one very long and slender, the other short and leaf-like. Hook-joint of the right side very strong, curved at first through about 90°, then curved through a widely obtuse angle; slightly thickened terminally, ending in a spike; a tooth on the proximal part. Hook-joint of the left side long, bent through 90°, ending in a spike.

Female (Mean, 3·30).—Shell elongate, of more triangular outline than in the male, because beginning to taper further back. Shoulder-ridge less marked, postero-ventral angle more sharply rounded than in the male. Postero-dorsal spines and rostrum as in the male. Ventral border arcuate; the greatest height behind the arcuation, thence tapering sharply forward. Frontal organ: the stem projects for some distance beyond the first antenna. Terminal joint nearly completely segmented from the stem, tapering slightly, depressed above, but not bent so much upwards as in the male. Spines more numerous on the dorsal border than in the male, extending over more than the proximal half. Antenna i. with a long dorsal bristle. Antenna ii. with two hairless central bristles, the one about two-thirds the length of the other, and with a long and a short basal bristle. The terminal bristles and tubes more or less beset with fine spines proximally: the longest but one with fine spines nearly throughout its length; the longest slightly lanceolate.

Stage III.

Male (Mean, 2·16).—Shell much as in Stage II. (the right shell of fig. 8 has a slightly more triangular appearance than the left of fig. 3, owing to the projecting gland-papilla). Frontal organ unsegmented, spineless, the terminal part not much thicker than the stem, ending in a blunt point. Antenna i. with the principal bristle of female character*. Antenna ii. as in Stage IV.

Female (Mean, 2·3).—Shell much as in Stage II., but rather less markedly triangular. Frontal organ unsegmented, spineless, much as in the male of the same stage. Antenna i. with a short dorsal bristle (not shown in fig. 16). Antenna ii. as in Stage II.

Stage IV.

Male.—A much broken specimen of ♂ 1·6 mm. was apparently referable to this: the frontal organ and inner branch of antenna ii. have been figured.

* This carried a straight dorsal bristle in one specimen, presumably as an abnormality; the same was occasionally noted in males of other species.

Female (Mean 1·42).—Shell much less triangular than in the later stages, owing to the ventral border being now slightly convex instead of arcuate. Spines, papillæ, and rostra as before, but rather shorter. Frontal organ still very long, unsegmented, terminal part only slightly thicker than the stem; ending bluntly, spineless. Antenna i. without dorsal bristle. Antenna ii. with central bristles as in Stage III.; no basal bristles.

Conchœcia brachyaskos, Müller.

(Plate 16. figs. 20–29.)

The specimens were unfortunately too few to allow of the successive stages being determined mathematically; but at least two male stages, and possibly three female stages, were recognizable: figures are given to help future observers. The shell of the only male of 0·9 mm. was unfortunately damaged before being drawn; it appeared, however, closely to resemble the larger specimens.

In addition to Müller's description (p. 70) it may be noted that the older shells generally carried a small spine, like that of *procera*. In the female, the frontal organ was generally curved downwards more than in Müller's figures (xiv. 7, 8). In the male, the teeth of the armature of the principal bristle of the first antenna (fig. 21) seemed rather more curved than in his drawing (xiv. 14). There were fifteen pairs of these teeth more or less opposite to one another, followed by four single teeth proximally. These differences were presumably within the limits of individual variation.

Conchœcia curta, Lubbock.

= *C. stigmatica*, Müller.

(Plate 17. figs. 30–54.)

The special difficulties presented by the shape and size of this species, which tend to obscure the successive stages, are mentioned in detail on pp. 259, 260. In the male, Stages I. and II. (the stages with secondary sexual characters) are pretty clear; the earlier stages are guesswork. In the female, the successive stages are little differentiated morphologically and are by no means clear. I should not have dared to associate *stigmatica* with the oldest stage of *curta* if the necessary confirmation by analogy had not been available from larger species, in which one is on more certain ground; but a careful comparison of the figures with the similar succession in other forms will, I think, leave no doubt of the correctness of the determination. The only point in which the succession differs from that observed in the other species lies in the reduction of the number of "teeth" on the principal bristle of antenna i. in the male; they are, however, quite rudimentary and inefficient, as compared with other species, at the previous "*curta* stage;" this being so, their further reduction at the "*stigmatica* stage" would seem to suggest that they are being abandoned.

It may be said that I have included two separate species under *curta*, and it is certainly possible; but the possibility has been steadily borne in mind, and I have found myself unable to split the species. Unfortunately the measurements of the older specimens are too few to give any clue, and are themselves somewhat chaotic. A large series of older specimens is needed to set the species on a proper footing.

The position of the opening of the right asymmetrical gland seems to be different in the various figures; this is mainly due to a dorsal or ventral tilting of the biconvex specimens: its real position appeared to be at or just below half the height, except in the very youngest specimens, where it is apparently higher.

Stage I. (*stigmatica* stage).

Male (about 1 mm.).—Shell with the shoulder-ridge very strongly marked *. The posterior border begins as a nearly straight line making an obtuse angle with the dorsal border; at the opening of the right asymmetrical gland it becomes a steady convex curve, which passes on without postero-ventral angle into the convex ventral border, and then turns up rapidly as a flattened curve towards the rostrum. Frontal organ much thicker than the stem, sometimes more flexed downwards than in fig. 31: thickest proximally, gradually tapered by depression of its dorsal border, the ventral border being nearly straight; ending bluntly, spineless. Antenna i.: the principal bristle carries 5–8 minute warts, very difficult to see. Antenna ii.: the right hook begins with a very broad base; becoming thinner, it commences to bend round with no trace of an angle, is thicker at the highest point of the bend, and then tapers with a slight S-curve, terminating in two divergent spines. The left hook, beginning with a thick base, shows a distinct angle, and then tapers gradually like the right hook. One proximal sense-tube is thickened at its base, and either dentate or spined. There are two subequal basal bristles; of the central bristles, the one is about twice the length of the other; all are hairless. (One of each was obscured by its fellow in fig. 33; compare fig. 37.)

Female (about 0·95 mm).—Shell: the posterior border begins to curve almost immediately after the postero-dorsal angle, and the curve is continued steadily till just below the rostrum; the antero-ventral border being more sharply curved and less flattened, the female shell has a more rounded and less pointed outline than in the male. Frontal organ showing a good deal of variation; always imperfectly segmented, bluntly rounded or truncated, spineless, straight or very slightly bent. Antenna i. with the distalmost sense-tube bifid, one branch being very short (fig. 47). Antenna ii. with two central bristles, the one about twice as long as the other, both hairless. No basal bristles.

Stage II. (*curta* stage).

Male (about 0·76 mm.).—Shell much as in Stage I., but a little higher for its length. Frontal organ strongly flexed downwards, slightly curved, thickest distally, terminating bluntly, spineless. Antenna i. with an armature of 9–12 † blunt points on the principal bristle. Antenna ii.: the right hook much as in Stage I., but with a thinner base; the left hook without an angle. One sense-tube is thickened at its base, which is dentate or spined.

Female (about 0·7 mm.).—Shell much as in Stage I. Frontal organ of the type

* This is so at every stage observed, and will not be repeated.

† Müller records 8–13, but I have not observed so great a range.

described and figured (xxx. 3) by Müller; it was not observed to show so much variation as at Stage I.; this may be accidental, as a good deal was observed at ? Stage III. below (0·5 mm.). Antenna ii. as in Stage I.

Earlier Stages.

Male (about 0·5 mm.).—Shell markedly resembling that of the female at the same length; posterior border rather straight; a steady curve from the gland-opening to just below the rostrum, not flattened antero-ventrally. Frontal organ unsegmented, nearly straight, sometimes tapered, ending bluntly. Antenna i. with principal bristle of female character. Antenna ii. carries one basal bristle (? two), and two central bristles as before.

Female (about 0·5 mm.).—Shell higher for its length than in the later stages, posterior border nearly straight, followed by a strong arching of the ventral border. Frontal organ exhibiting similar variation to Stage I.; the commonest type is shown in fig. 51. Antenna ii. as in later stages.

Figures are also given of (? ♀) shells at 0·45 and 0·39 mm., which may perhaps illustrate earlier stages.

Conchœcia daphnoides, Claus.
(Plate 17. figs. 55–57.)

Both males and females at Stage I. were fairly numerous. I have no doubt that what has been described as *lacerta*, Brady & Norman, and *daphnoides*, var. *minor*, Müller, form Stage II. of this species *, but it was not taken by the 'Research' on this occasion. A single specimen of Stage III. was, however, captured.

In supplement to Müller's description, it may be noted that in the male nine reversed teeth were counted at the distal end of the armature of the principal bristle, and that the proximal bristle carried a few fairly stout teeth. In the female, the inner branch of antenna ii. resembled Müller's figure of the male (xxxi. 13), except, of course, for the absence of the hook, and sometimes carried one basal bristle; the three sense-tubes were spined proximally, the two bristles distally.

The shells and frontal organ of Stage III. are figured. In antenna ii. the central bristles were as in Stage I., but hairless; there was no basal bristle; the terminal bristles and tubes were spineless.

Conchœcia elegans, Sars.
(Plates 17, 18. figs. 58–73.)

Stage II.

Male (Mean, ±1·1).—Shell without marked shoulder-ridge (unlike *spinirostris*); generally with two sharp spines on the postero-dorsal angle of the right shell; below the spines the posterior border is concave for a short distance, then convex. The opening of the right asymmetrical gland does not project as in *procera*; it lies at the postero-ventral angle of the shell, not far forward as in *procera*; the angle is well-marked as the meeting-point of the posterior and ventral borders, unlike *spinifera*.

* Compare p. 263 note.

Ventral border convex; the shell is highest about the middle of the length. Frontal organ very short, of the form drawn by Müller (xiii. 20) or as in figure 59. Antennæ i. and ii. as drawn or described by Müller (xiii. 21, 22, 26).

Female (Mean, ±1·12).—Shell of the same character as in the male, except that on the posterior border the upper part is generally more deeply concave, the lower more sharply convex. The ventral border somewhat more tapered than in the male. Frontal organ and Antenna i. as drawn by Müller (xiii.* 10, 11, 24), the former projecting only a short distance beyond the latter (unlike *spinifera* and *procera*). Antenna ii. without basal bristles, with two short hairless central bristles, the one about twice the length of the other.

The extent of the concavity of the posterior border is more or less impressive, according as the spines are more or less developed; but the convexity is always greater in the female than in the male.

Stage III.

Male (Mean, ±0·9).—Shell much as in Stage II., but slightly more tapered anteriorly†. Frontal organ unsegmented, the terminal part swollen, ending bluntly. Antenna i. with the principal bristle of female character. Antenna ii. as in the female, except for the presence of a single basal bristle.

Female (Mean, ±0·86).—Shell with the posterior border as in Stage I., but the ventral border is more convex, and the shell therefore higher in proportion to the length. Frontal organ very larval in character, only slightly swollen terminally. Antenna ii. as in Stage II.

It is very difficult to distinguish these young specimens at first from Stage III. of *spinifera*. But the frontal organ, which in *elegans* only just projects beyond antenna i. extends in *spinifera* a long way beyond it. Further, *spinifera* has a well-marked shoulder-ridge; and was not observed at this stage to carry a spine, whereas *elegans* generally does. The ventral border is more convex in *elegans*, straighter in *spinifera*. The characteristic openings of the marginal glands in *elegans*, figured for Stage I. by Müller (xiii. 19), are very imperfectly developed at this and earlier stages.

Stage IV.

Shells (♂ ♀ Mean, ±0·6) of both male and female as in their respective sexes at Stage III., except that the ventral border is more convex, and the shell is fuller in front, so that the highest point lies a little in front of the middle of the length. No postero-dorsal spine was observed at this stage. The male was distinguishable from the female only by the rudiments of the penis. Cephalic organs as in Stage III. female.

* Figure 29, between figs. 21 and 25 on this plate, should apparently be 23, and of a male.

† The specimen drawn in fig. 60 had the spines rather better developed than that of fig. 58; hence at first the postero-dorsal concavity appears to be more strongly marked.

Stage V.

Female.—Shell with nearly straight posterior border and deeply convex ventral border. Cephalic organs as in Stage II. female, except that there was only one central bristle on antenna ii.

Conchœcia haddoni, Brady & Norman.
(Plates 18, 19. figs. 73–89.)

Müller expresses the opinion (p. 90) that a larger southern race (♀ 2·6—2·95, ♂ 2·2—2·5)* can be distinguished from a smaller northern race (♀ only up to 2·6, ♂ to 1·9), but he recognises that this idea is opposed to the fact that Brady's specimens from 53° N. (coast of Ireland) belonged to the larger race. He regards a re-investigation of the specimens as urgently needed for the certain identification of the species. My specimens of Stage I. are also large (up to 3 mm.), and leave absolutely no doubt of their identity with the species of Müller and of Brady and Norman; it is enough to say that they agree point for point, and it is unnecessary to re-describe and re-figure every detail. The collection is short of males, but the extreme sizes which he gives for females (2·2–2·95) are well within the limits of size-variation of the older stages of a large adult.

Stage I.

Female (Mean, 2·72).—Shell with the posterior border slightly concave above, convex below; no recognisable postero-ventral angle; the opening of the right asymmetrical gland is on the posterior border at about one-third of the height; it is not prominent at any stage of either sex; the shell is highest behind the centre of the length. In Dr. Müller's figure (xviii. 1) the shell is apparently much higher posteriorly than in my figure 78, but the rostrum shows that the specimen had fallen slightly forward; my specimens present a similar outline when in the same position. Frontal organ and Antenna i. as figured by Müller (xviii. 3, 4, 8). Antenna ii.: the long basal bristle may carry a few short hairs; there is also a small bunch of hairs, difficult to find, on the joint just proximal of this bristle.

Male (2·1 mm.).—Shell with the posterior border slightly concave above, but the convex curve protrudes less behind a perpendicular from the postero-dorsal angle than in the female; the ventral border is convex; the highest point at about the middle of the length. Frontal organ and Antenna i. as drawn by Müller (xviii. 6, 7). Antenna ii. with one unusually long basal bristle, and one very short; of the central bristles, the one is about two-thirds of the length of the other, both are long and with fine short hairs. Some of the terminal bristles and tubes with hairs, as in the female.

Stage II.

Female (Mean, 1·66).—Shell with the posterior border as in Stage I.; the ventral border convex, so that the greatest height is now about the middle of the length.

* His figure of a female measures 2·8 without the rostrum.

Frontal organ unsegmented, spineless, swollen anteriorly. Antenna ii. retaining the long basal bristle; the hairs on the terminal bristles and tubes few or absent.

Male (Mean, ? ±1·45).—This stage was not observed.

Stage III.

Female (Mean, 1·01).—Shell with the posterior border not projecting so far posteriorly as in the later stages; the ventral border is more sharply convex; the height more than half the length. Frontal organ fairly long, blunt, spineless, somewhat swollen anteriorly. Antenna ii. with a short basal bristle, difficult to see in most positions. No hairs on the terminal bristles or tubes.

Male (1·0 mm.).—Shell with the posterior border as in Stage I., but the height rather greater in proportion to the length. Frontal organ as in the female of this stage, but rather shorter. Antenna i. with the principal bristle of female character. Antenna ii. much as in the female. No hairs on any of the bristles.

Stage IV.

Female (Mean, 0·66).—Shell more sharply convex ventrally than in Stage III. Antenna ii. with no basal bristles and only one long central bristle.

Male.—This stage was not observed.

In Stages III. and IV. the large gland-cells described and figured by Müller (xviii. 2) were sometimes very conspicuous.

Stage V.

Female (of 0·4 mm.).—The high position of the opening of the right asymmetrical gland seems to indicate that this was attributable to *haddoni*. Shell with the height about five-sevenths of the length, very sharply convex ventrally. Frontal organ much as in Stage IV. Antenna ii. as in Stage IV.

Male of this stage not observed.

Conchœcia hyalophyllum, Claus.
= *C. lophura*, Müller.

(Plates 19, 20. figs. 90–109.)

Stage I. (*lophura* stage).

Female (Mean, ±2·3).—Shell with the posterior border forming a flattened curve; no marked postero-ventral angle; the ventral border slightly arcuate, and the shell higher behind the arcuation than in front. Lateral glands well-marked; a collection of long cells on the ventral border of the left shell behind the arcuation was less pronounced than in Müller's figure of *lophura* (xx. 2), but clearly recognisable. Frontal organ incompletely segmented; the terminal joint gradually enlarging distally, then abruptly constricted ventrally to form a sharp, downwardly directed spine. There are numerous fine spines on the dorsal border, and stout spines on the ventral border; the whole structure closely resembling that figured by Müller for *lophura* (xx. 10). Antenna i. with a long dorsal bristle carrying fine hairs. Antenna ii. with two central bristles;

the longer, which carries stout short hairs, is nearly twice the length of the shorter, which carries comparatively few fine hairs.

Only one well-preserved specimen was observed, with a length of 2·5 mm. (34*f*, 750–500 fm.). A poorly preserved specimen of 2·1 mm. may also be referable to this species (23*a*, 1000–750 fm.).

Male (Mean, ±2·1).—Shell elongate, with a well-marked shoulder-ridge. Posterior border nearly straight, and nearly at right angles to the dorsal border; postero-ventral angle not marked; ventral border slightly arcuate, the shell about as high in front of the arcuation as behind it. Lateral glands conspicuous, and there is a collection of long gland-cells on the ventral border of the left shell behind the arcuation (compare Müller's figure xx. 2). Frontal organ with the terminal joint very thick proximally, constricted about the middle of its length, expanding again to a rounded end. Antenna i. with an armature showing about 66 teeth in profile view (it was not possible to make out how many of these 66 were in pairs); the teeth are very small, closely set, and as figured by Müller (xx. 4), except that they appeared to be more sharply pointed. Antenna ii. as drawn by Müller (xx. 7, 9): there is one long fine basal bristle with fine hairs, and one very short bristle; the longer of the two central bristles carries short stout hairs distally as well as the long setæ proximally.

A single specimen, 2·3 mm. in length, was taken in the non-comparable haul 36 *l* (350-0 fm.).

Stage II. (*hyalophyllum* stage).

Female (Mean, 1·58).—Shell markedly resembling that of *magna* at Stage II., but the posterior border is more sharply rounded, and on the ventral border the shell is slightly higher behind than in front of the arcuation; consequently the shell tapers more anteriorly. Frontal organ and Antenna i. as drawn by Müller (xx. 23, 24): the terminal joint of the frontal organ has the dorsal and ventral borders less parallel than in *magna*; it swells gradually from the base towards the tip (not suddenly as in *parvidentata*); at the tip it is suddenly reduced to a sharp spine. The small spines on the organ are more numerous than in *magna*, and are more concentrated anteriorly and ventrally. The dorsal bristle of antenna i. carries numerous very fine hairs; in proportion to the diameter of the bristle they are larger than *magna* Stage II., but are almost equally difficult to see. Antenna ii. with the bristles much as in *magna*.

Male (Mean, 1·50).—Shell much as in *magna* Stage II., but less arcuate and with somewhat stronger shoulder-ridge. Ventral border very slightly arcuate, rising anteriorly sooner than in *magna*; shell about as high in front of the arcuation as behind it. The lateral glands are often very difficult to see, both in male and female; one seldom finds more indication of them than the three little points shown in fig. 97. Frontal organ with the terminal joint curved as in *magna*, but not so much constricted in the middle (fig. 94); both ends nearly of the same thickness. Antenna i.: the principal flagellum is a little longer than the two secondary flagella. The armature is very difficult to make out, the teeth being, as a rule, hardly longer than those on the principal flagellum of the female in many species. It appears to consist of about 22

pairs of minute teeth, set at about their own length from one another, followed proximally by 15–20 pairs of similar teeth which are spaced more widely apart. Antenna ii. as drawn by Müller (xx. 20, 21): but the long hairs of the longer central bristle are often missing (? dropped off); the shorter bristle may carry a few short hairs. Of the basal bristles, the one is rather longer than the other (the foreshortening in camera drawings is apt to mislead).

Stage III.

Female (Mean, 1·07).—Shell practically indistinguishable from that of *magna* Stage III., except for the lateral glands. Frontal organ of the same general type as in Stage I., but less swollen, unsegmented, projecting far beyond the antenna. Antenna i. with a hairless dorsal bristle. Antenna ii. with the central bristles as in Stage I., but smaller. No basal bristles.

Male (Mean, 1·08).—Shell practically indistinguishable from that of *magna* Stage III., except for the lateral glands. Frontal organ resembling that of the female Stage I., except that it shows no segmentation, and carries fewer and shorter spines. Antenna i. with the three flagella clearly differentiated, the secondary a little more than half the length of the principal. Armature of female character. Antenna ii. without hooks; the central bristles as in female Stage I., but smaller. No basal bristles.

Stage IV.

Male (Mean, 0·7).—Shell as in Stage II., but slightly higher in front of the arcuation than behind it. Frontal organ swollen terminally, unsegmented, still bearing a terminal spike.

Female of this stage not observed.

Conchœcia imbricata (Brady pars), Müller.
(Plate 20. figs. 110–121.)

Four stages were recognised in this species, of which only the oldest showed secondary sexual characters in the male. From the analogy of other forms, I have no doubt that a yet larger stage exists, and is to be found in deep water.

Müller records (p. 118) the lengths of 3·0 to 3·5 for females, 2·5 to 3·0 for males. Measurements of his figure (xxviii. 1) show that he included rostrum and posterior spine in the "length," and that his specimens corresponded to my Stage II., with means of 2·34 ♀, 2·01 ♂.

Stage II.

Female (Mean, 2·34).—Shell agreeing with that described and figured by Müller (xxxviii. 1). Frontal organ sometimes rather more curved than in Müller's xxxviii. fig. 3, beset thickly with stout spines on the proximal fifth of its dorsal border and proximal half of its ventral border. Antenna i. with hairless dorsal bristle. Antenna ii.:

the one central bristle about two-thirds of the length of the other. No basal bristles. Two of the sense-tubes carry proximally sharp teeth.

Male (Mean, 2·01).—Shell much as in the female of the same stage. Antenna i.: the principal flagellum carries 17–20 teeth in all, which in profile look like 8–10 pairs, but proximally are not quite symmetrical. There are a few fine spines on the accessory flagellum opposite the distal end of this row of teeth. Antenna ii. with two central bristles, one rather longer than the other; and a small basal bristle.

Stage III.

Female (Mean, 1·50).—Shell much as in Stage II. Frontal organ long, straight, unsegmented, the future terminal joint rather thicker than the stem. Antenna i. with hairless dorsal bristle. Antenna ii. with central bristles as in Stage II.; at least one sense-tube with a few proximal teeth.

Male (Mean, 1·48).—Shell much as in female of the same stage. Frontal organ and Antenna i. resembling those of the female at the same stage except for the absence of a dorsal bristle. Antenna ii. with central bristles as in the female, with the addition of one basal bristle. No hook-joint as yet developed.

Stage IV.

Female (Mean, 0·96).—Shell shorter for its height than in the later Stages II.–III.; squarer and less triangular in outline; the highest point of the shell is now about the middle of the length instead of being behind it. Rostrum proportionately shorter. Frontal organ simple, straight, unconstricted, nearly equally thick throughout its length, slightly pointed. Antenna i. without dorsal bristle. Antenna ii.: longer central bristle about twice the shorter one; no teeth on sense-tubes.

Male (Mean, 1·0) agrees with the female of the same length in all the points just mentioned; distinguishable by the presence of the penis.

Stage V.

Female (Mean, 0·66).—Shell still shorter for its height, and rostrum shorter. The postero-dorsal spines nearly of the same length; the postero-ventral prominences persist.

Male of this stage not observed.

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Conchœcia inermis, Claus.
(Plate 20. figs. 122–126.)

Only three specimens were observed, ♂ 1·5, 1·9, ♀ 2·0. Of these the two longer agreed with Müller's description; the third was a male without secondary sexual characters.

Stage ? II.

Male (1·9).—Shell very long, the height is to the length about as 1 is to 2·7. Shoulder-ridge fairly marked, postero-dorsal angle rounded off, posterior border nearly straight and nearly at right angles to the dorsal border; the opening of the right asym-

metrical gland is at the marked postero-ventral angle and is rather prominent. Ventral border a steady convex curve, rather flattened; rostrum of the long flattened type of the *imbricata* and *daphnoides* groups. The asymmetrical glands are in the usual position: on the anterior border are numerous long gland-cells which do not appear to meet in a common opening; they are particularly noticeable on the right shell. Frontal organ strongly flexed ventrally, blunt, spineless. Antenna i.: the principal bristle carries very numerous, long, fine spines as in the *daphnoides* group; the two rows are widely apart and the spines very divergent, directed proximally; they are succeeded distally by five or six short distally directed spines. The proximal accessory bristle carries about 10–15 pairs of very small spines, regularly set in pairs, on a level with the distal end of the armature of the principal bristle. Antenna ii. as described and figured by Müller (ix. 27); the two basal bristles short, nearly equal in length.

Female (2·0 mm.).—Shell very elongate; the height is to the length about as 1 : 2·5; it is of the same general contour as in the male *. Frontal organ as described and figured by Müller (x. 6). Antenna ii. with two central bristles, the shorter about three-quarters of the longer: both hairless.

Stage ? III.

Male (1·5 mm.).—Shell rather fuller in front or less tapered than in Stage ? II.; the height is to the length about as 1 : 2·6. Otherwise much as in Stage ? II. Frontal organ straight, constricted between the stem and the future terminal joint, but not completely segmented; terminal part swollen, ending in a blunt point directed slightly downwards. Antenna i. with principal bristle of female character. Antenna ii. with one basal bristle; two central bristles as in Stage ? II.; no hook-joint.

Conchœcia kampta, Müller.

Two males, one of 2·5 mm., the other with broken shells, carried unmistakably the characters of the first and second antennæ of this species. There were about 48 pairs of leaflets on the principal bristles, and the distal accessory bristle carried about 19 strong teeth (not pairs). The stage would seem to be the same as that described by Müller.

Conchœcia loricata, Claus.

= *loricata*, var. *typica*, Müller.
= *ctenophora*, Müller.

(Plates 20, 21. figs. 127–138.)

A number of specimens were obviously referable to some member of the *loricata* group, which includes only *loricata*, var. *typica* and var. *minor*, *ctenophora*, and (perhaps) *serrulata*. So far as the 'Research' specimens were concerned, *serrulata* was out of the question by reason of the shell-form.

The points in which var. *minor* and *ctenophora* differ from var. *typica* are given very

* Müller states that his specimens were "meist stark deformiert, zum Theil auf mikroskopische Präparate": this accounts for his drawing of the female (xi. 25).

briefly by Müller; they are: (1) the extent to which the shell-sculpture is recognisable, (2) the number and arrangement of the teeth on the principal bristle of antenna i., and (3) the size of the shell. The first of these three points seems to be quite unreliable for diagnosis in formalin specimens: of two otherwise absolutely similar specimens from the same haul, the one would show well-marked sculpture, in the other it would be barely visible; this was noticeable in other species also. The other two diagnostic points might be (and in the case of the two larger "species" they probably are) merely expressions of different ages or stages of the same species. Müller furnishes the following particulars:—

	Teeth.	Size.
loricata, var. *minor*	± 12	♀ 1·6–1·7, ♂ 1·5 *.
„ „ *typica*	± 22	♀ 1·8–2·0, ♂ 1·7–1·9 †.
ctenophora	± 30	♀ 2·4–2·6, ♂ 2·3–2·6.

By size and by number of teeth my specimens were *ctenophora*; in every other respect they agreed with Müller's description of *loricata*, var. *typica*. If, as I believe, these are merely the last two stages of one species, the older name *loricata* claims priority.

Stage I. (*ctenophora* stage).

Male (Mean, 2·31).—Shell more tapered anteriorly, and with a more marked shoulder-ridge than in *magna*, posterior border nearly straight and at right angles to the dorsal border, postero-ventral asymmetrical gland prominent, ventral border arcuate; the shell not so high in front of the arcuation as behind it, the anterior border beginning to taper upwards immediately after the arcuation. Frontal organ much as in *magna*, about as thick after the central constriction as before. Antenna i.: the toothed and proximal toothless parts of the principal bristle subequal, the distal toothless part longer. Teeth about 30–32 pairs, nearly all equal and nearly equidistant at all points. The principal somewhat longer than the accessory bristles, which carry a few minute teeth. Antenna ii. with the inner branch as drawn by Müller (xxii. 17), but the longer central bristle is often (not always) hairless, and the larger basal bristle is longer and slenderer than (owing to foreshortening) appears in this figure. The process on the inner side of the proximal part of the hook appears to be constant, and not to occur in *magna*.

Female (Mean, 2·58).—Shell with fairly marked shoulder-ridge. Posterior border beginning above with a slight concavity, then markedly convex, projecting further posteriorly than in the male. Ventral border fuller than in the male behind the arcuation, so that the highest point of the shell lies well behind the middle of the length. Otherwise as in the male. Frontal organ and Antenna i. as drawn by Müller (xxii. 3).

* Figure without rostrum, 1·4.

† Figure without rostrum, 1·7.

Antenna ii. with slender central bristles, the one nearly twice the length of the other; hairs, if present, extremely minute. No basal bristles.

In both sexes and notably in the female the lateral glands are often difficult to see: the gland of the left shell is often more easily detected with a low power than its opening with a high power. In many specimens the anterior ventral part of the shell is extraordinarily glandular.

Stage II. (*loricata* stage).

Male (Mean, 1·75).—Shell much as in Stage I.; intermediate between that figured by Müller (xxii. 12) for *loricata*, var. *minor*, and that which he gives for *loricata*, var. *typica* (xxii. 1), in that the posterior border is more nearly perpendicular to the dorsal border than in the typical form; but the ventral border is more tapered, with the highest point behind the middle of the shell, as in the smaller variety. The lateral glands are in the usual position for the species. Frontal organ as figured by Müller (xxii. 4). Antenna i. with about 22 pairs of teeth, the paired arrangement is practically carried out to the proximal end of the rows, unlike the markedly alternating condition noticeable in *magna* at this stage. The distal accessory bristle carried about 13 fine teeth; the proximal had also a few, which were difficult to see. Antenna ii. as drawn by Müller (xxii. 6, 7), except that the hairs on the longer central bristle were not quite so long in my specimens.

Female (Mean, 2·0).—Shell much as in Stage I.; the lateral glands present, but difficult to see; the posterior border not so prominent as in Stage I. Cephalic organs as described and figured by Müller (xxii. 3), except that fine hairs occurred on more than one terminal bristle.

Stage III.

Male (1·4).—Shell more tapered antero-ventrally than in later stages, and therefore more resembling their female type; the lateral glands clearly visible. Frontal organ long, unsegmented; the terminal part slightly thicker than the stem, the end bent strongly downwards to a blunt spike. Antenna i. with principal bristle of female character. Antenna ii. with one basal and two central bristles, all hairless.

Female (Mean, 1·3).—Shell very much as in Stage II.; lateral gland visible. Frontal organ unsegmented; the terminal part thicker than the stem; its blunt spike not so much bent downwards as in the male at this stage. Antenna i. without a dorsal bristle. Antenna ii. as in the male of this stage, but without a basal bristle.

Conchœcia magna, Claus.

= *macrocheira*, Müller.

(Plates 21, 22. figs. 139–160.)

This was the most plentiful of the larger forms in the collection, and was apparently represented by five stages. But it was hard to settle under what name it should go, owing to the difficulty of deciding whether the penultimate stage belonged to *subarcuata*, Claus, or to *magna*, Claus; these two names are of the same date. The original source

of the difficulty may lie in Claus having had both ultimate and penultimate stages before him *.

The differences which Müller in his text points out between these species are two:— (1) Differences in the armature of the principal bristle of antenna i.; in my specimens the proximal teeth are displaced, generally less so than in his figure of *magna* (xxi. 26), more so than in his description of *subarcuata*. They are spaced as in his figure of *subarcuata* (xxi. 12) and not shaped quite like those of *magna* (xxi. 26). Claus assigns about 20 pairs of teeth to *magna*, set more closely and more regularly distally than proximally †; this agrees with my specimens; but to *subarcuata* he attributes 30 pairs. (2) Differences in the hook of the inner branch of antenna ii. The right hook in my specimens agrees better with *magna* than with *subarcuata* in being bent at first sharply through a right angle, and then curved boldly through a second right angle; on the other hand, it is said by both Müller and Claus that in *subarcuata* it is bent at first through an acute angle ‡. (3) In Claus's figures, the posterior border of the male shell of *subarcuata* (iii. 3) begins with a concave curve, and projects much further than that of *magna* (iii. 1). My shells agree best with *magna*.

On the whole it seems that the penultimate stage of the 'Research' specimens must be assigned to *magna*, Claus, leaving open the question whether the *subarcuata* of Claus and Müller is founded on individual variation of *magna*, or is a separate species.

Stage I. (*macrocheira* stage).

Female (Mean, 3·36).—Shell very oblong; shoulder-ridge slight; postero-dorsal angle slightly rounded, posterior border a steady curve; right asymmetrical gland slightly projecting; ventral border arcuate, the shell about as high in front of the arcuation as behind it; anterior border bluff, rounded. Frontal organ and Antenna i. as drawn by Müller (xxi. 5, 6), with the addition of a bunch of short spines on the terminal joint of antenna i. at the base of the principal bristle. Dorsal bristle with long hairs. Antenna ii. with its inner branch as drawn by Müller (xxi. 8). No basal bristles.

Male (Mean, 2·91).—Shell of the same general outline as in the female, except for (1) a more marked shoulder-ridge, (2) a straighter posterior border, (3) a more forwardly projecting rostrum. Frontal organ as drawn by Müller (xxi. 7). Antenna i.: the armature covers a little less than a third of the length of the principal bristle; it amounts to about 29–31 pairs of teeth; the order in pairs is retained throughout the row; the first few and last few are shorter and closer together than the rest. Accessory bristles

* It is even possible that *magna* and *subarcuata* are one species, allowing for individual variation.

† The displacement of the teeth from a regularly paired row into an alternating series is often difficult to deal with, since a very slight twist of the axis of the bristle serves to produce this effect: in two antennæ of the same specimen, the teeth may appear at first to be greatly displaced proximally in the one, hardly at all in the other. Further, unless the teeth are in exact profile, refraction will sometimes produce the effect of a second tooth behind the first, on focussing downwards.

‡ Here again, as with the armature of antenna i., everything depends upon getting the organ into exact profile in one focal plane; if it be tilted away from the observer, a right angle may easily look like an acute angle.

about as long as the principal bristle, with a few minute teeth. Antenna ii. with its inner branch as drawn by Müller (xxi. 3). The longer central bristle carries numerous long fine hairs (?8–10 pairs); both central bristles are curved, especially the shorter. The longer basal bristle is about twice the length of the shorter.

Stage II. (*magna* stage).

Female (Mean, 1·88).—Shell much as in the subsequent Stage I., but the rostrum is less markedly bent downwards and the shoulder-ridge slightly more marked. Frontal organ much as drawn by Müller (Nap. Monogr. 1894, pl. v. fig. 8), but slightly more swollen anteriorly, though not so much so as in *hyalophyllum*. Terminal spike very rarely suppressed. Antenna i. with a long slender dorsal bristle carrying a few extremely minute hairs. Antenna ii.: the longer central bristle carries fewer hairs than in the subsequent Stage I. No basal bristles.

Male (Mean, 1·77).—Shell much as in subsequent Stage I., but the anterior border rises more sharply, giving a less bluff-bowed outline. Frontal organ much as in subsequent stage. Antenna i. without spines on the terminal joint. The armature of the principal bristle formed by 21–23 pairs of teeth, not markedly shorter at the ends than in the middle; the distal teeth rather closer together; about the middle of the row (compare Müller, xxi. 12) the pairs are rather further apart, and the teeth are not set quite evenly opposite one another, yet are not so markedly displaced as in Müller's drawing of *subarcuata* (xxi. 26); they are also more slender and longer than in that figure. Antenna ii. as figured by Müller (xxi. 17, 18); the hairs on the longer central bristle fewer than in the subsequent stage (apparently 2–5 pairs). Longer basal bristle about twice the length of the shorter.

Stage III.

Female (Mean, 1·14).—Shell of the same general type as in the later stages, but shorter and higher; shoulder-ridge hardly developed. Opening of the left asymmetrical gland slightly prominent above the dorsal border when viewed from the right side. The shell is sometimes slightly higher in front of the arcuation than behind it. Frontal organ unsegmented, acutely pointed, the terminal part very little thicker than the shaft. The pointed tip is usually in, or nearly in, the same line as the axis of the organ, but is occasionally slightly bent downwards * (fig. 159). There are a few fine spines on the ventral surface. Antenna i. with a short thickish dorsal bristle, not carrying hairs. Antenna ii. with the longer central bristle generally carrying a few fine hairs, but sometimes it is bald

Male (Mean, 1·22).—Shell of a more female character than in subsequent stages; that is to say, the rostrum is more downwardly directed, and the posterior border more curved. The shell is often slightly higher in front of the arcuation than behind it; and is practically indistinguishable from the female shell of the same stage. Frontal organ unsegmented; the terminal portion is slightly broader than the shaft, generally

* Query, *hyalophyllum*? but no lateral glands were detected.

acutely pointed, with a few fine spines ventrally. Sometimes the point is less developed, or the organ ends bluntly *. Antenna i. The principal bristle is of female character, that is, it carries a few scattered minute teeth. The two secondary flagella are a good deal shorter than the principal and are differentiated from the sense-tubes. Antenna ii. without hooks; there are (?) no basal bristles; the longer central bristles carry short hairs as in the female of this stage.

The two sexes can generally only be distinguished at this stage by the three bristles of antenna i. in the male, and by the presence of the penis (not always easily seen).

The A Larvæ.
(Plates 21, 22. figs. 161–168.)

The morphology of the larvæ classed under this head leaves little doubt that the greater number of them are attributable to *magna*. But it became obvious, at an early period of the general investigation, that other forms were possibly represented among them, namely *hyalophyllum*, *zetesios*, *spinirostris*, and *loricata*, forms belonging to the *magna* and *loricata* groups †. The specimens of these larvæ were very numerous, and the difficulties of determining their length and sex were considerable. It is possible that they might have been disentangled by another six months of work, but even then a satisfactory result was not assured beforehand, nor did the probable gain seem likely to compensate for the labour involved. All the larvæ, therefore, which exhibited certain characters have been classed as "A."

The negative characters were:—the general shape of the shell, in not showing the rounded contours of *curta*, *pusilla*, and *rotundata* (species which are eliminated by other tests), or the elongate type of *procera*, *brachyaskos*, *elegans*, *spinifera*, and *inermis*, or the elongate rostra of *daphnoides*, *imbricata*, and *ametra*; and the opening of the right asymmetrical gland, not projecting as in *rhynchena*, nor displaced dorsally as in *haddoni*; in several of these species the larvæ have been satisfactorily identified.

The positive characters were a nearly straight posterior border, a straight or slightly arcuate ventral border, with the greatest height of the shell markedly in front of the middle of the length; a normal position of the asymmetrical glands, the opening of the left one protruding above the dorsal border when viewed from the right side; the frontal organ and central bristles of the second antenna closely resembling the type found in *magna* at Stage III. The two latter characters, combined with a general similarity of appearance (which is naturally more striking in the actual specimens than in outline drawings), are the reasons for regarding the typical A larvæ as belonging to *magna*. Their characters may be thus defined:—

Stage IV. (Mean ± 0·8).

The males and females are only distinguishable from one another by the presence or absence of the two rudiments of the penis. Shell with a nearly straight posterior border,

* Query, another species? but no other difference from the normal type was detected.

† It is conceivable that the members of the *mollis* group, namely *kampta* and *tyloda*, may have had epiplanktonic larvæ; but as only two adult specimens of each were taken, they can be left out of count.

which makes nearly a right angle with the dorsal border; postero-ventral angle rounded; ventral border sometimes slightly arcuate, generally straight, sloping downwards so that the highest point of the shell is well in front of the middle of the length. Frontal organ unsegmented, the future terminal joint thicker than the stem; its dorsal border rising a little (sometimes sharply) at about half the length; its ventral border convex and with a few fine teeth in the male; terminating acutely. Antenna i. with the principal bristle of female character in both sexes; no differentiation of the accessory bristles from the sense-tubes in the male, no dorsal bristle in the female. Antenna ii. with two central bristles on the inner branch, the one more than twice the length of the other and provided with a few stout hairs.

Stage V. (Mean $\pm$ 0·5).

Shell much as in Stage IV., but rather shorter for its height, and with the downward slope of the ventral border more marked. Frontal organ and Antenna i. much as in Stage IV. Antenna ii. with a single short stout central bristle carrying a few short hairs.

Conchœcia procera, Müller.
? = *C. decipiens*, Müller.

(Plate 22. figs. 169–183.)

Only one sexual male stage was represented in the Biscayan collections, and this agreed with the form hitherto described as *procera*. But the presumption is that a second (final) male form exists in this as in the larger species. It seems likely that this is to be found in the species named *decipiens* by Müller, which he himself (p. 72) at first ranked as *procera*, and only separated from it later in his investigation. *Procera* occurred at all but one of the nine 'Valdivia' stations from which he records *decipiens*, and there is nothing in his description of the latter to make its identification with *procera* improbable.

Stage II.

Shell with the length more than twice the height, shoulder-ridge marked, postero-dorsal angle rounded, posterior border convex; no postero-ventral angle is perceptible on the left side, but on the right side the posterior and ventral borders meet at the opening of the asymmetrical gland as two distinct curves; the opening is prominent, and is placed further forward than is usual in other species. A small spine may or may not be present on the right shell.

Male (Mean, 1·11).—About twenty pairs of teeth on the principal bristle of antenna i. are not uncommon. There are sometimes a few short hairs on the longer central bristle of antenna ii.

Female (Mean, 1·16).—In figure 176 is drawn a slightly different type of antenna i. from those drawn by Müller (xiv. 3 to 6) showing the "Albatross-bill" end which occurs in *cophopyga* and *brachyaskos*.

Stage III.

Male (Mean, 0·9).—Shell much as in Stage II., but the shoulder-ridge is not so marked. Frontal organ simple, straight, unsegmented, the terminal joint not thicker than the stem, ending sharply. Antenna i. with the principal bristle of female type. Antenna ii.: the shorter central bristle is about three-fourths of the longer, the latter may carry a few short hairs; one (? two) short basal bristles.

Female (Mean, 0·9).—Shell much as in Stage II., but the shoulder-ridge is not so marked. Frontal organ still projecting far beyond the end of antenna i., simple, unsegmented, the terminal joint rather thicker than the stem, the end tapered. Antenna ii. as in Stage II.

Stage IV.

Male (Mean, 0·65).—Shell with the height and length about equal; the ventral border more sharply convex than in the later stages. Frontal organ ending bluntly, simple, straight, still projecting well beyond the end of antenna i. Antenna ii. as in fig. 181 (female).

Female (Mean, 0·62).—Shell more sharply convex ventrally than in the male of this stage, height rather more than half the length. Frontal organ still very long, the future terminal joint hardly thicker than the stem, tapering to a point. Antenna ii. with one long and one very short central bristle.

Stage V.

Female? (0·5).—Shell much as in Stage IV. Frontal organ long, but of the simplest type, slightly swollen towards the end, ending bluntly.

Conchœcia pusilla, Müller, var. major, Müller.

(Plates 22, 23. figs. 184–187.)

Only six specimens of this form were taken. In supplement to Müller's description, it may be noted that it is at first extremely difficult to detect that the armature of the principal bristle of antenna i. in the male consists of foliate plates and not of fine spines; their real form can only be seen if they are in exactly the right position. There were about seven pairs, more or less in a double row, followed proximally by about seven more (not pairs) more widely spaced, appearing as a single row but really set alternately in a double row. As Müller's figure of the shell (xvii. 36) was drawn from a "stark verbogene" specimen, the right shell of an undamaged specimen has been figured. In the female of 0·8 mm. the frontal organ was as drawn in Müller's figure xvi. 35; in the female of 0·6 as in his figure xvi. 36; there were two central bristles on the inner branch of antenna ii., the shorter about three-fourths of the longer, both very slender and hairless.

Conchœcia rhynchena, Müller.
(Plate 23. figs. 188–204.)

The specimens showed only one male stage with secondary sexual characters: it is possible that *kampta* or *tyloda* may be the oldest stage of this species. However this may be, the *rhynchena* stage is here regarded as Stage II.

Stage II.

The shells were a little less elongate than in Müller's figure (xxvi. 21), but the characters of antenna i. in the male left no doubt of the identification. In both sexes the opening of the right asymmetrical gland projects markedly beyond the shell-outline (figs. 190, 195); the left lateral gland is found at the pronounced angle between the posterior and the ventral borders. The following notes are supplemental to Müller's description.

Male (Mean, 2·28).—Antenna i. The armature (*Blättchen*) of the principal bristle was observed to amount to about 53 pairs of foliate teeth. The pad (*Schwiele*) on the proximal accessory bristle appeared to be formed by an increase in the diameter of the appendage, strengthened by chitinous three-quarter-rings; it is opposite to the distal half of the armature of the principal bristle: distal to it, are about eight pairs of stout teeth, the pairs set widely apart from one another. On the distal accessory bristle are 20–40 pairs of stouter teeth, approximately opposite to the pad. Antenna ii.: there are two central and two basal bristles, the shorter in each case is about one-half the length of the other; all are apparently hairless.

Female (Mean, 2·47).—The spines on the Frontal organ were rather stouter and fewer than in Müller's figure (xxvi. 17 *a*), but it agreed with this in general contour. The terminal joint is markedly segmented from the stem. I have added drawings of slightly sharper and blunter specimens, but all show the same general type and spination. Antenna ii.: the central bristles as in the male, no basal bristles.

As some difficulty was found at first in separating this from ♀ *loricata*, subjoined are the conspicuous differences between them.

Rhynchena ♀. Posterior border nearly straight, nearly perpendicular to the dorsal angle, no arcuation of the ventral border, marked sculpture at the anterior end of the shell. Postero-dorsal glands present, frontal organ segmented from the stem, opening of the right asymmetrical gland markedly projecting.

Loricata ♀. Posterior border convex, extending behind the perpendicular from the dorsal border, ventral border arcuate, sculpture of the anterior end of the shell inconspicuous. No postero-dorsal glands, frontal organ incompletely segmented from the stem, opening of the right asymmetrical gland conspicuous but not markedly projecting beyond the shell-outline.

Stage III.

Male (Mean observed* 1·75, probable ± 1·55).—Shell rather less elongate than in the subsequent Stage II., posterior border slightly convex, opening of right asymmetrical gland slightly projecting as before. (The rostrum in fig. 190 is not quite in profile, and looks shorter than it really is.) Frontal organ unsegmented, the future terminal

* Only two specimens of this stage were seen.

joint swollen on the ventral border, diminishing suddenly to a narrower tip, the end rounded and carrying an insignificant spike; a few fine spines on the ventral border. Antenna i. with the principal bristle of female character. Antenna ii. without hooks, the central bristles as in the later stage: there are two basal bristles, the one very tiny, the other fairly long.

Female (Mean, 1·60).—Shell slightly more elongate than in Stage II., but retaining the projecting opening of the right asymmetrical gland and the postero-dorsal glands. Frontal organ thicker than the stem, but incompletely segmented from it, tapering to a blunt tip, carrying a few fine spines ventrally. Antenna i. with a hairless dorsal bristle (accidentally omitted in fig. 200). Antenna ii. with the shorter central bristle about two-thirds of the other; both hairless.

Stage IV.

Male (Length, 1·1).—Shell with postero-ventral angle more rounded than in Stage III., posterior border at a slightly obtuse angle to the dorsal border, ventral border nearly straight; opening of right asymmetrical gland prominent, postero-dorsal glands just recognisable. Frontal organ short, slightly thicker than the stem, unsegmented, spineless. Antenna ii. with one fine basal bristle (? two); the shorter central bristle half the length of the other, both hairless.

Female (Mean, 1·04).—Shell with postero-ventral angle more rounded, postero-dorsal angle more obtuse, and ventral border more convex than in later stages; the highest point of the shell lies at about the middle of its length. Opening of the right asymmetrical gland projecting, but postero-dorsal glands not recognizable. Frontal organ elongate, simple, the terminal joint not segmented from the stem, ending bluntly; one or two fine spines on the ventral surface. Antenna i. without dorsal bristle. Antenna ii. with central bristles as in the male.

Stage V.

Female (Mean, 0·70).—Shell sharply convex ventrally; the opening of the right asymmetrical gland is prominent, but does not project so much as in the later stages. The left lateral gland is already distinguishable, but very small. Frontal organ simple, short, blunt; the future terminal joint slightly thicker than the stem, constricted distally. Antenna ii. with a single hairless bristle of medium length.

The specimens at 0·6 mm. may perhaps belong to an earlier Stage VI., but their determination is naturally rather uncertain. In them the opening of the right asymmetrical gland resembled that of *macromma* (Müller, xvii. 12), and was very high up, at nearly half the height of the shell.

Conchœcia rotundata, Müller.

(Plates 23, 24. figs. 205–224.)

According to Dr. Müller, the shells of this species exhibited a remarkable variation in shape, the height being anything from 41 to 57 per cent. of the length. Now in all other Halocypridæ which I have handled the shell-shape is very fairly constant, and the general contour gives one of the most reliable specific characters, but its diagnostic

value would be seriously weakened if so great a range of variation were possible as is shown in Müller's figures, pl. xvii. 23, 24, and 25, 26. Fortunately, it appears that this extreme range of possible contour is due, not to individual variation, but to the different shapes of the shells at Stages I. and II. So far as I have seen (with the exception of one abnormal specimen*) all specimens at Stage I. were of the elongate type; at Stage II. they are never so elongate as at Stage I., although both exhibit a certain amount of individual variation. At the earlier stage they become even more rounded. A glance at the figures of the shells on Plate 24 will show the changes of form which accompany the successive metamorphoses.

For reasons which will appear in the Developmental Part (p. 273), the means are only wide approximations.

Stage I.

Male (Mean, 1·0).—Shell very elongate; the height to the length as 1 to 1·9; the opening of the left asymmetrical gland far forward, near the rostral incision. The shoulder-ridge slight; the posterior angle markedly rounded, the posterior border strongly convex, the ventral angle markedly rounded; the ventral border nearly straight and generally almost parallel to the dorsal border, the shell being very slightly highest in the posterior third. Frontal organ and Antenna i. as described and figured by Müller (xvii. 29, 34); the armature of the principal bristle consists of about 10–12 pairs of spines, of which the distalmost five or six pairs are close together, the more proximal are placed at gradually increasing intervals. Antenna ii. as described by Müller; there are two very small basal bristles; of the central bristles the one is about twice the length of the other; both are hairless.

Female (Mean, 1·1).—Shell very elongate; the length may be more than twice the height; the shell is sometimes more markedly highest in the posterior third than is shown in fig. 215. The posterior border is more sharply convex than in the male, but otherwise similar to it. Frontal organ rather variable: the normal type as in fig. 216 (compare Müller's figures, xvii. 30 to 33). Antenna ii. with two hairless central bristles, the longer about twice the length of the shorter; sometimes with two tiny spines in the position of basal bristles.

Stage II.

Male (Mean, 0·75).—Shell much less elongate. The height to the length about as 1 to 1·7. From the posterior end of the dorsal border runs a steady sharply-convex curve, which is unbroken till just below the rostrum, obliterating the posterior angles. The greatest height is near the middle of the length, the ventral border strongly convex. Frontal organ with short, sharply segmented, terminal joint; the dorsal border depressed about the middle of its length, with a few fine spines proximally; the ventral border correspondingly swollen, then constricted, with numerous fine spines, ending

* The specimen, a male of 1·0 mm., that is to say of the length of Stage I., had not developed secondary sexual characters—the armature of the principal bristle of antenna i., the hook-joint on antenna ii., and the form and spinulation of the frontal organ; it had been arrested at Stage III. Such cases of arrested sexuality have been described from other groups; the testes were rather small, but I could see no trace of "parasitic castration."

bluntly. The general type is that of Stage I., but shorter and plumper. Antenna i. with an armature of about 8 or 9 pairs of spines, the distal four or five pairs close together, the remaining pairs set at increasing distances from one another. Antenna ii. as in Stage I., but with no basal bristles.

Female (Mean, 0·79). –Shell much less elongate, the height to the length about as 1 to 1·4 or 1·5; the greatest height behind the middle of the length. Frontal organ less spinous, but otherwise this and the antennæ resemble those of Stage I.

Stage III.

Male (Mean, 0·61).—Shell much as in Stage II. but shorter; the height to the length about as 1 to 1·4; both posterior and ventral borders very sharply convex, the greatest height about the middle of the length. Frontal organ resembling that of the female at Stage II., with a very few spines on the ventral border. Antenna i. with the principal bristle of female character. Antenna ii. without hook-joint, otherwise resembling that of the later stage.

Female (Mean, 0·61).—Shell of about the same proportion of height to length as in the later Stage II., but more semicircular, owing to the greater rounding of the postero-ventral angle. The opening of the left asymmetrical gland further back in the length. Frontal organ blunt, spineless, straighter.

Stage IV.

Male (Mean, 0·41).—Shell projecting less behind a perpendicular from the posterior end of the dorsal border; opening of left asymmetrical gland far back. Frontal organ spineless, unsegmented, but much as in Stage III.

Female (Mean, 0·40).—Shell much as in Stage III. Frontal organ straight and undifferentiated. Antenna ii. without central bristles.

Conchœcia spinifera, Claus.
(Plate 24. figs. 225–235.)

Three stages were represented, of which only one showed male secondary sexual characters. The oldest captured is therefore considered to be Stage II.

Stage II.

Female (Mean, 2·12).—Shell with marked shoulder-ridge; the posterior border of the left shell is nearly at right angles to the dorsal border (except for the slightly truncated postero-dorsal angle); on the right shell, a slight convexity under the spines precedes the gently curved posterior border, The opening of the right asymmetrical gland is approximately at the postero-ventral angle; is is not prominent beyond the shell-outline. The ventral border gently convex; the highest point of the shell is at about the middle of the shell-length. A group of (generally four) large granular gland-cells is almost always to be found near the antero-ventral angle. Frontal organ and Antenna i. as figured by Müller (ix. 14, 15) except that the dorsal bristle of antenna i. was observed to reach nearly to the end of the frontal organ. Antenna ii. with two

central bristles, the one about two-thirds of the other, each with a very few fine short hairs. One at least of the terminal bristles may carry a row of short spines.

Male (Mean, 1·80).—Shell not markedly different from that of the female. In the specimen drawn in figure 225 a blunt process replaced the spines; this may have been due to damage; the spines are generally conspicuous. The characteristic cephalic organs as drawn by Müller (pl. ix.).

Stage III.

Female (Mean, 1·44).—Shell of the same character as in Stage II., but the rostrum somewhat less markedly bent downwards. The antero-ventral gland-cells persist. Frontal organ spineless, unsegmented; of the same general character as in Stage II., that is, a swollen convex ventral border is suddenly decreased anteriorly to form with the dorsal border an acute tip. Antenna i. usually (? always) without a dorsal bristle. Antenna ii. as in Stage II., but the central bristles are apparently hairless.

Male (Mean, 1·41).—Shell as in Stage II. Frontal organ approaching the female type of Stages II. and III., but shorter, and with the dorsal border rising suddenly about the middle of the future terminal joint; spineless, unsegmented. Antenna i. with the principal bristle of female type. Antenna ii. as in female of Stage II.

Stage IV.

Female (Mean, 0·98).—Shell much as in the later stages, but the posterior border is rather straighter, and is not shaved off so much at the postero-ventral angle. One or two of the large antero-ventral gland-cells are generally recognisable. The spines of the right shell are sometimes present. Frontal organ ending bluntly, the ventral border decreasing suddenly near the tip as before: the organ is shorter in proportion to the antennæ. Antenna ii. with the longer central bristle about twice the length of the shorter.

Male (Mean, 1·03).—Practically indistinguishable from the female, except for the rudiments of the penis.

Conchœcia spinirostris, Claus.

= *C. porrecta*, Claus.

(Plates 24, 25. figs. 236–246.)

The relation of the different stages is discussed in the Developmental Part (p. 276).

Stage I. (*porrecta* stage).

Male (1·3 mm.). Shell of the type of *magna* male: the shoulder-ridge well developed; the opening of the right asymmetrical gland rather prominent posteriorly. The posterior border nearly at right angles to the dorsal border, with a slight re-entrant curve; ventral border nearly straight. Frontal organ much thicker than the stem; constricted centrally, thickest distally; spines very few and short. Antenna i.: the armature of the principal bristle appeared to consist of about 16 pairs of saw-like teeth, followed by about 11 pairs of spine-teeth; the latter so markedly alternate as to suggest

a single row unless viewed directly from above. Antenna ii. as figured for Stage II.; the shorter central bristle about two-thirds of the longer; the latter with a few very long hairs; there are two basal bristles, the one more than twice the length of the other, both slender and hairless.

The exact shape of the saw-teeth is difficult to make out owing to their minuteness and high refraction. They appeared to have rather the shape given in fig. 238 than that shown in Müller's drawing (xxii. 25). The sub-cuticular teeth shown in his figure appeared in one specimen at Stage II., and probably indicated an approaching moult.

Female of this stage not observed.

Stage II. (*spinirostris* stage).

Male (Mean, 0·93).—This is hardly distinguishable from Stage I., but (1) the posterior border of the shell is rather straighter; (2) the teeth on the armature of the principal bristle of antenna i. were about 8–11 pairs of saw-teeth and about 8–9 pairs of spine-teeth; (3) the frontal organ was rather slenderer, not much thicker than the stem.

Female (Mean, 1·10).—Shell with a sharply curved posterior border, and a fairly prominent opening to the right asymmetrical gland; no postero-ventral angle. The ventral border is very slightly arcuate, the highest point well behind the middle of the shell-length; tapering gradually forwards. Frontal organ of very larval appearance, spineless, unsegmented, only slightly swollen anteriorly, terminated acutely. Antenna ii. with the shorter central bristle about two-thirds the length of the longer, the latter with a few fine short hairs at its base. No basal bristles.

The female is difficult to identify, owing to the fact that the frontal organ has the characters (or, rather, absence of positive characters) which one has learnt to associate with larvæ of earlier stages in other species (smoothness, transparence, symmetry of dorsal and ventral borders, thin wall, absence of segmentation, &c.). But as some females carried comparatively large ova (0·08 mm. diam.) they were not far from maturity.

Stage III.

Male not observed.

Female (Mean, 0·75).—Shell with the posterior border straighter than at Stage II.; no postero-ventral angle, ventral border slightly convex. Frontal organ as in Stage II., but shorter. Antenna ii. with two central bristles as in Stage II., but hairless.

Conchœcia tyloda, Müller.

A single male specimen of 2·8 mm. in fair preservation agreed with Müller's figures and description. On the principal bristle of antenna i. there seemed to be about 57 pairs of leaf-like structures (which at first look like very fine spines), distal of these are 3 or 4 short spines directed distally. Antenna ii. carried two basal bristles (Müller figures one only), the one about two-thirds the length of the other.

A pair of empty shells which carried the characters of this species was also taken; their length was ±2·7 mm.

Conchœcia zetesios, sp. n.
(Plate 25. figs. 247–253.)

Only females of this undescribed form were taken by the 'Research,' representing two stages and in very small numbers. The species obviously belongs to the *magna* group. While the shell-contour to some extent resembles that of '*macrocheira*,' its frontal organ and the slender longer bristle of the inner joint of antenna ii. are very far from the *magna-macrocheira* type; nor can it be fitted into the lengths which have been worked out for that series. It is remotely possible that it may be a dimorphic parthenogenetic form of *magna*, but parthenogenesis has not yet been shown to occur in the Halocyprida (compare p. 308).

Stage (?) I.*

Female (Mean, 2·42)—Shell very foursquare, shoulder-ridge slight; the posterior border steadily convex; the opening of the right asymmetrical gland rather high, that of the left rather far forward; no postero-ventral angle; the ventral border very long, markedly arcuate, generally so full anteriorly that the highest point of the shell is in front of the arcuation; the anterior border very bluff; the rostrum so bent downwards that its anterior face is at right angles to the dorsal border, and if produced would nearly (or quite) make a tangent to the anterior border. Frontal organ very long; the terminal joint imperfectly segmented from the stem; the proximal half of the terminal joint is rather thicker than the stem; the distal half is much thicker and terminates in a blunt downwardly directed spine; it carries a few spines on its dorsal border only. Antenna i. with a very long dorsal bristle, the distal half of which carries long fine hairs. Antenna ii. with a very low peg (*Warze, Mamillar-höcker*), devoid of basal bristles; the longer central bristle is about twice the length of the shorter and carries short hairs; the shorter also in some cases has hairs.

Stage (?) II.

Female (Mean, 1·5).—Shell with a more convex posterior border; the anterior part of the ventral border is fuller, so that the highest point of the shell is far in front of the arcuation; the rostrum is bent at first downwards, then inwards; in other respects the shell is as in the later stage. Frontal organ of the same general type as in the later stage, but less swollen and spineless. Antenna i. with a dorsal bristle, shorter than in the later stage, and hairless. Antenna ii. as in the later stage.

Conchœcia B.
(Plate 25. figs. 254–257.)

A single female from 22 *b* (750-500 fathoms), 1·7 mm. in length, was possibly referable to the penultimate stage of *dorsotuberculata*. The general outline of the shells agrees sufficiently with Müller's figure x. 1, allowance being made for a small difference between the sexes. The opening of the left asymmetrical gland is not nearly so far forward as in *dorsotuberculata*, but is further forward than is normal in

* The ovary was in all cases so poorly developed, that it is possible that the specimens were only semi-mature.

Conchœcia; it is possible that (as certainly happens in *rotundata*) the opening shifts forward with successive moults.

Shell very elongate, the length about twice the height; dorsal border straight; opening of left asymmetrical gland about $\frac{1}{5}$ of the border from the postero-dorsal angle. Posterior border a steady curve, meeting the ventral border without any postero-ventral angle; ventral border parallel to dorsal border, slightly arcuate centrally; the anterior border beginning very far forward. The right asymmetrical gland in the usual position. Frontal organ with three long fine spines dorsally, and about ten ventrally. Antenna i. with a dorsal bristle carrying very minute hairs. Antenna ii. with two central bristles, the longer nearly twice the length of the shorter, and with short stout hairs; the shorter with fine hairs.

If it be not *dorsotuberculata*, the specimen probably belongs to an undescribed species.

Conchœcia C.

(Plate 25. figs. 258–262.)

A single male with secondary sexual characters, 1·1 mm. long, occurred in haul 35 *i* (500–400 fathoms). A comparison of the figures given here with Müller's figures of *haddoni*, *incisa*, *ortholrichota*, &c. (pls. 18, 19) will show that the specimen is obviously referable to his *bispinosa* group. The shells had been slightly damaged, but I saw no trace of a postero-dorsal spine; the angle had, however, somewhat suffered.

It may possibly prove to be a small specimen of the penultimate stage of *haddoni*, but the size and the supposed contour of the postero-dorsal angle are against this. In addition to the features figured, may be mentioned that the armature of the principal bristle of antenna i. (which I failed to get into profile position for drawing) much resembled that of *incisa* (Müller, xix. 7), and consisted of about 18 pairs of fine close-set teeth, markedly directed backwards; there were two central bristles on antenna ii., the one about two-thirds the length of the other.

Halocypris globosa, Claus.

(Plates 25, 26. figs. 263–278.)

Stage I.

Male (2·1 mm.)*.—Shell with the height about $\frac{2}{3}$ (65 p. c.) of the length; the two shells together, viewed from a longitudinal vertical plane, are not subspherical as in the female, but are hardly thicker from right to left than in an ordinary *Conchœcia*. Rostrum well developed, forwardly directed, placed at the end of the dorsal border, not far down the anterior border as in the female. Shoulder-ridge inconspicuous, postero-dorsal angle rounded, posterior border a steady curve with the opening of the right asymmetrical gland about the middle of the height, no postero-ventral angle. The ventral border flatter than in the female. Frontal organ short, straight, segmented; without hairs or spines; the terminal joint forms a slight angle with the thicker stem, and is thinnest about the middle of its length. Antenna i. of female type, with four

* Müller's single specimen was 2·25 mm.; the specimens were probably at the oldest stage, if *Halocypris* follows the proportions usual in *Conchœcia*.

sense-tubes subequal in length, and one long bristle which carries few minute hairs. Antenna ii. The right and left hooks are nearly symmetrical and subequal: the right is rather the stouter of the two; it begins by a short straight piece, and after an angle forms a sickle-shaped curve. The two central bristles (much foreshortened in fig. 267) are subequal, the one carrying short fine hairs. There are two basal bristles, the one nearly twice the length of the other.

The single specimen was in fair condition, fortunately, as the cephalic organs were hitherto undescribed.

Female (Mean, 2·51).—Shell with the height about 73 per cent.* of the length. The two shells together form almost a sphere when viewed from a longitudinal vertical plane. The postero-dorsal angle is rounded, the posterior border slightly convex, no postero-ventral angle, a strongly convex ventral border. Rostrum bent sharply downwards, its apex at about two-thirds of the height of the shell; it projects very little beyond the anterior border. Frontal organ as described and figured by Müller (viii. 19), with the addition usually of a thickened groove (? joint) near the base of the terminal segment. Antenna i. as described by Müller. Antenna ii. with two central bristles, the one about two-thirds of the length of the other, both hairless; there is sometimes also a small basal bristle.

Stage II.

Female (Mean, 1·54).—Shell with the height about 84 per cent. of the length; it agrees with Stage I. except in being proportionately higher. Cephalic organs as in Stage I.

Stage III.

Female (Mean, 0·95).—Shell nearly as high as long, very sharply curved ventrally. Cephalic organs as in later stages.

Stage IV.

Female (Mean, 0·61).—Shell as in Stage III. Frontal organ and antenna i. as in later stages. Antenna ii. with one long central bristle.

Stage V.

Female (0·4 mm.).—Shell as in Stage IV. The frontal organ and antenna i. were unfortunately broken in dissecting the single specimen. Antenna ii. as in Stage IV.

Archiconchœcia cucullata, Brady.

Two males and two females of this rare species were captured. The females were apparently at Stage II. or III., but offered no structural differences from Müller's description and figures which require comment here.

* The specimen figured by Dr. Müller (viii. 13) appears to have been tilted a little ventrally.

CYPRIDINIDÆ.

Cypridina castanea, Brady.
(Plate 26. figs. 279–281.)

Two females, apparently of Stages I. and II., respectively about 6·0 and 4·0 mm. in length, occurred in haul 32 *m*. The larger specimen carried ova free between the shells posteriorly. The smaller was pale in colour, except for the eyes, and for the stomach which had already the "chestnut" tint of the adult.

Besides these, two larvæ of 1·8 mm. and one of 1·9 mm. were taken. Dr. Müller figures (xxxiv. 10) a larva of this description, but does not give its length. As he points out, the shells are more circular and less elliptical at this early stage.

The complicated arrangement of bristles and selvage (*Saum*) at the rostrum, which he figures (xxxiv. 12) for the adult, is not quite identical with that of these larvæ (fig. 281); the selvage is traceable from above the rostrum along the ventral border as far, at least, as the most prominent point of the posterior border, but is very narrow on the ventral and posterior borders.

The younger stage is probably identical with Vavrá's *Cypridina obesa*.

Gigantocypris pellucida, Müller.
(Plate 26. fig. 282.)

Two specimens, the one perfect (and, if I remember right, alive), were obtained from great depths. By size they belonged to Müller's species *pellucida*: the perfect specimen measured about 13 mm.; in the other the shells were much crumpled and torn, but they seemed to be of about the same length. I regard it, however, as possible that *pellucida* is the penultimate stage of *agassizii*.

The 13 mm. specimen (which was not dissected) contained about 23 embryos between the shells posteriorly: one of these was extracted and is represented in fig. 282; it was still encased in a shell-membrane, and showed five pairs of appendages; the shell-edges had already begun to grow downwards.

This and *Cypridina castanea* were the only cases noticed, in the whole collection, of ova or embryos being carried by the mother after extrusion.

III. DEVELOPMENTAL PART.

The general method of handling the question of the successive moults—(1) by plotting the numbers observed at each length and noting the range of the curves thus formed; (2) by testing these with a growth-factor found empirically—has been sufficiently explained in the Introduction (pp. 224–226). The supposed law of growth by approximately similar increments at successive moults, here styled Brooks's law, requires to be re-tested on larger Crustacea, where a hundredth of a millimetre will be a negligible

percentage of the measurements involved *. The present work, based on such unfortunately small forms as Ostracoda, can at best be merely pioneer work, and cannot pretend to mathematical accuracy. The means here given can only be approximations in most cases, owing not only to the minuteness but also to the scarcity of specimens. Although in this case unavoidable, it is, mathematically speaking, an absurdity to treat less than a hundred cases for problems of frequency. If the means are only approximate, so also must be the growth-factors. Further, it is possible that not only are the means and growth-factors mere approximations, but also the law itself, as here phrased. The actual increase at each moult is probably not so simple that the same growth-factor will apply *exactly* at every moult, even in Ostracoda of small size and few stages; and, as will be seen later in a discussion of measurements of crabs and lobsters, the factor certainly undergoes modification as growth proceeds, in large forms with numerous moults. On the other hand, I have little doubt that the law as phrased on p. 224 is a sufficiently accurate weapon for the zoologist to use in combination with the morphological evidence, even if the words "*fixed* percentage" may require revision at the hands of the mathematician.

After writing the larger part of this paper, I had the great advantage of the help and criticism of Professor Karl Pearson from the mathematical standpoint. He expressed the opinion that while valid statistical evidence is given here in many cases for that separation of the stages which I have proposed, in others this evidence is wanting [in some of these latter, however, it is supplied by the morphological changes which indicate that an intermediate moult has occurred]. Professor Pearson, regarding the "staircase-growth" of Crustacea [discontinuous growth by moults] as likely to fit in eventually with the laws of growth of other organisms, pointed out that Brooks's law could only fit in with a relatively small portion of the general growth-curve; that it might be a reasonable approximation to a portion of it, but that mathematically it is clear that many other formulæ would accomplish the same result; that in most cases I have only recorded three stages, and have accordingly only two ratios of growth, and that if these were not very widely different one might easily get a mean value within the probable error of the results. In sum, he was not convinced of my conclusions being more than a first approximation based on three stages. With this verdict I am content. I believe that I have carried the matter about as far as Ostracoda will admit, and must leave to others the further development of the suggested law of growth on more favourable material.

It is reasonable to suppose that all the species of *Conchœcia* follow the same rhythm of moults; and on this is based the working supposition that they all exhibit two stages with secondary sexual characters in the male. These two stages have been recorded (in one or both sexes, in this or other memoirs) for *curta*, *daphnoides*, *elegans*, *haddoni*, *hyalophyllum*, *loricata*, *magna*, *rotundata*, and *spinirostris* (supposing, that is, that my identifications are correct); and their occurrence has consequently been inferred in *ametra*, *imbricata*, *procera*, *rhynchena*, and *spinifera*.

* Observations on lobsters and crabs will be found on pp. 279–281.

HALOCYPRIDÆ.

Conchœcia ametra, Müller.

The specimens captured were unfortunately far too few to yield satisfactory means, but three stages are clearly visible in both sexes.

The actual observations were as follows:—

	♀.	mm.	♂.	
Stage II. Mean, 3·30.	2	3·5		
	1	3·4		
	4	3.3		
	4	3·2	1	Stage II. Mean, 3·10.
		3·1	2	
		3·0	1	
Stage III. Mean, 2·3.	1	2·3	1	Stage III. Mean, 2·16.
		2·2	1	
		2·1		
		2·0	1	
		1·6	1	Stage IV. Mean, 1·6.
Stage IV. Mean, 1·42.	1	1·5		
	4	1·4		

Table B.—Total specimens measured: 17 ♀ + 8 ♂ = 25.

Taking an approximate growth-factor of 1·5 mm. for females and 1·4 for males, the unknown Stage I. of this species would measure about 5·0 mm. in the female, and 4·4 in the male.

Conchœcia brachyaskos, Müller.

It would have been clear that there were at least two male and two female stages here, even if anatomical study had not shown them; but the specimens were too few to allow of any guess at their mathematical relations.

The actual observations are as follows:—

♀.	mm.	♂.
1	1·4	
	1·3	
4	1·2	
	1·1	
2	1·0	
2	0·9	1
1	0·8	

Table C.—Total specimens measured: 10 ♀ + 6 ♂ = 16.

Conchœcia curta, Lubbock.

This species is by no means easy to manipulate; it is very difficult to poise the almost spherical shells in the profile position which is necessary for accurate measurement and drawing, and the shells are thin and readily distorted. Further, owing to its small size,

the successive stages seemed to overlap as in *rotundata* (p. 273). While this overlap may be partly due to the comparatively rough method of measurement adopted, it is certainly the case at one point that the highest measurements of one stage coincide with or actually overlap the lowest measurements of the next oldest stage. Thus, for example, in a few male specimens measured to a second place of decimals, at Stage II. (lower sexual stage) were found the lengths 0·82, 0·80, 0·78, 0·75, 0·73 mm.; and at Stage III. (without secondary sexual characters) the maximum length observed was 0·82 mm.

On the whole, the possible errors were so great that it did not seem worth while to take a long series of measurements, as has been done with most of the other species described. There are not only the personal error, the errors due to parallax and refraction, the error due to faulty position of the specimens, and the large error due to distortion of the shell, to be considered; these all apply also to bigger species (in which they would seriously affect the *second* place of decimals); but, further, all these errors are intensified by the minuteness of the specimens of *curta*, so that they together amount to a far larger "percentage error" than in the larger forms.

A good many specimens were measured to a second place of decimals (about $\frac{1}{50}$ mm.). The results seemed to be perfectly worthless. The only chance of accurate measurement to a second place was of an undistorted shell from the inside—that is, of the right shell when the left has been turned back; this was often impossible when the animal's body lay over the posterior border, or its appendages over the anterior border; and a comparison of such measurements with those taken before the shell was opened (when the true edges cannot be seen), or taken from the turned-back shell (distorted by opening), gave widely different results.

If my association of *stigmatica* with *curta* be correct, we can recognize in the males a Stage I. ("*stigmatica* stage"), with a mean somewhere about 1·0 mm.; a Stage II. ("*curta* stage"), which may be at least as long as 0·82 mm., and as short as 0·73 mm.; and a Stage III. (without secondary sexual characters), which may be as long as 0·82 mm., and is probably a later stage than the numerous specimens of about 0·55 mm. In the female the stages seem to be impossible to separate with any precision, as there is less morphological alteration from stage to stage than in the male; but I think that Stage I. had a mean of about 0·9 * or 1·0 mm., Stage II. about 0·7 mm., and Stage III. about 0·5 mm.

This total result is eminently unsatisfactory as compared with that obtained from the larger species; but a longer series of measurements from the 'Research' collections would not better it, because the weakest point of fewest measurements lies about Stages I. and II., and the larger specimens (of 0·9 and more mm.) were entirely confined to the lower strata (below 400 fathoms), from which every available specimen has already been measured. Nor would additional measurements of the smaller specimens (except in order to draw a line between male Stages II. and III.) avail to resolve the overlapping

* It is noticeable that according to Müller the *curta* group is almost unique in having the males equal to or longer than the females.

curves, in the absence of marked morphological differentiation. The mean of 14 males at Stage II. measured to the second place was 0·76 mm., which seems to show that the curve, the apex of which is at 0·7, contains the materials of two curves.

The actual measurements from which the curves in fig. B have been plotted are as follows:—

♀.	mm.	♂.
	1·1	1
7	1·0	6
13	0·9	
10	0·8	8
37	0·7	22
7	0·6	8
44	0·5	31
3	0·4	
3	0·3	

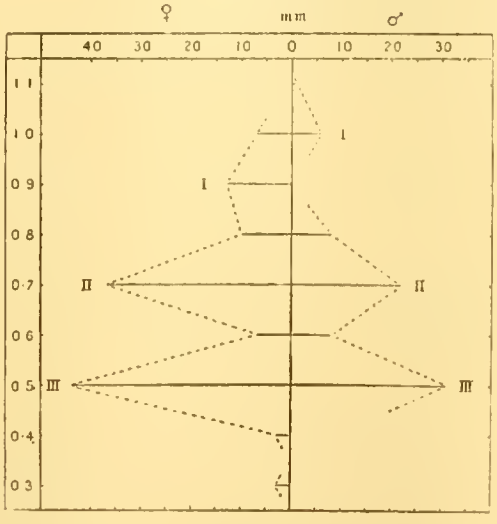
Table D.—Total specimens measured: 124 ♀ + 76 ♂ = 200.

It being impossible to get a satisfactory mean of the lengths, owing to the overlapping of the curves, it is worth notice that the modes of the curves of the (supposed) three oldest stages correspond to Brooks's law as well as could be expected:—

Males: growth-factor, 1·42.	Females: growth-factor.
0·50 × 1·42 = 0·71	0·50 × 1·40 = 0·70
0·71 × 1·42 = 1·00	0·70 × 1·40 = 0·98

Until a more accurate method of measurement for these minute specimens has been devised, this approximation will have to serve.

Fig. B.



Conchœcia daphnoides, Claus.

The best method of measurement for this species required consideration, because the contour of the shell is so utterly different from that of the other species handled.

Judging by the lengths recorded, Dr. Müller seems to have measured a "length over all," from the tip of the rostrum to the tip of the posterior spine. This was not adopted, firstly, because both spine and rostrum are often broken or bent; secondly, because, as they appear to be disproportionately longer in the older stages, they would probably not give a true standard of comparative growth at different stages; thirdly, because the measurement over all would not be comparable with those made in the other species, where the "length" is from the projection of the anterior border below the antennal incision, backwards, parallel to the dorsal border. Fortunately, it is generally easy to open and turn back the left shell in *daphnoides*, without serious distortion; this having been done, the base of the 0 on the micrometer-ocular scale was laid carefully to the most prominent point on the anterior border of the left shell, the scale laid as closely parallel as possible to the dorsal border; the point where the posterior curve upwards to the spine intersected the base-line of the scale was then read as the "length." This reading seemed to be at any rate comparable with that taken in other species; but the experimental error is perhaps rather greater in *daphnoides*, as the posterior curve probably varies in radius to some extent. While therefore the individual measurements are perhaps less accurate than in the other larger species, they are, doubtless, sufficiently so to give a reliable mean, owing to their number.

Judging by the analogy of more plentiful species, there can be little doubt that *daphnoides* var. *minor*, Müller (=*lacerta*, Brady & Norman), is the penultimate stage of *daphnoides* var. *typica*, Müller, that is to say, the lower stage with secondary sexual characters. Unfortunately this stage was not represented in the Biscayan collections, but a rough measurement of Müller's figure (xxxi. 1) yields a length of about 1·8, measured by my method. A few specimens of var. *typica* were measured by both methods, but no relation appeared between the two sets of figures *.

The actual measurements were as follows:—

	♀.	mm.	♂.	
Stage I. Mean, 3·08.	1	3·5		
	1	3·4		
	5	3·3		
	41	3·2		
	15	3·1		
	31	3·0		
	9	2·9		
	5	2·8		
	2	2·7		
	1	2·6		
		2·5	11	Stage I. Mean, 2·34.
		2·4	24	
		2·3	48	
		2·2	5	
Stage III.	1	1·2		

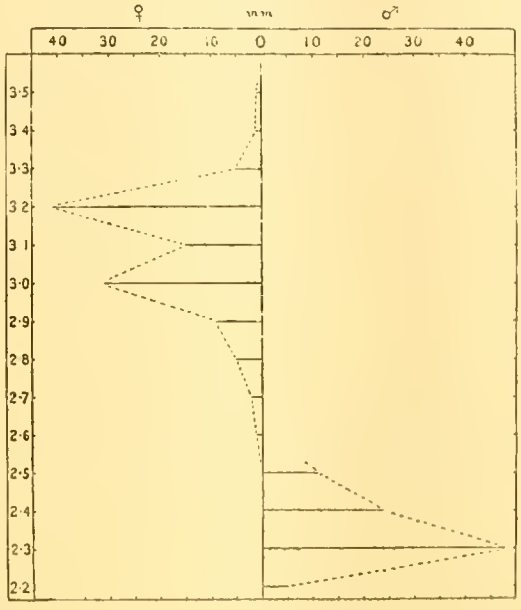
TABLE E.—Total specimens measured: 112 ♀ + 88 ♂ = 200.

* From tip of rostrum to tip of spine they varied from 5·0 to 5·5 mm.

In addition to the numerous specimens of Stage I. there was a single female specimen of (apparently) Stage III.; this with the aid of a slide-rule enables one to make an empiric guess at the mean of Stage II. With a growth-factor of 1·6 for females it appears that $1{\cdot}2 \times 1{\cdot}6 = 1{\cdot}92$; $1{\cdot}92 \times 1{\cdot}6 = 3{\cdot}07$; and we may fairly presume that the mean of Stage II. will be a little more or less than 1·9 mm.*.

It will be noticed that the curve of females at Stage I. shows a distinct double hump, which can hardly be attributed to scarcity of specimens.

Fig. C.



CONCHŒCIA ELEGANS, Sars.

This species presents the same difficulty as some of the other small forms—namely, of an overlapping of the curves in the male between Stages II. and III.; some specimens of 1·0 mm. were observed to have not yet developed secondary sexual characters which were already shown by others at 0·9 mm. The same thing appeared to be the case in the females at Stages IV.–III., III.–II., but their smaller morphological differentiation renders it less obvious.

As in *rotundata* (p. 273) and *curta* (p. 259), the differences in length between the successive stages are so small that measurement to only one place of decimals does not bring out clearly the boundaries between stages which are so noticeable in larger species, such as *magna*.

In consequence of these two unfavourable conditions, it is not possible to get really satisfactory means for the various stages; but, taking the means for female specimens (compare fig. D, p. 264) of 1·1 and 1·2 mm., of 0·8 and 0·9 mm., and the median at 0·6, so as to eliminate the probable overlapping at 1·0 and 0·7 mm., we arrive at the series 0·6, 0·86, and 1·12. To this a fair approximation can be got by a growth-factor of 1·32:

* Since this was written, I have measured the two specimens of "*lacerta*" taken by the 'Research' in the Faeroe Channel (Proc. Zool. Soc. 1903, p. 122) and now in the British Museum. They were females of 2·0 mm. in length.

0·65 × 1·32 = 0·858; 0·86 × 1·32 = 1·13; 1·13 × 1·32 = 1·49. This is as close as can be expected in so small a species, where the unmeasured hundredths of a millimetre are no doubt important.

It is obvious from the lengths recorded by Müller ('Valdivia' specimens, ♀ 1·1–1·65, ♂ 1·0–1·7) that Stage I., with a mean somewhere about 1·5 mm., was missing in the Biscayan collections.

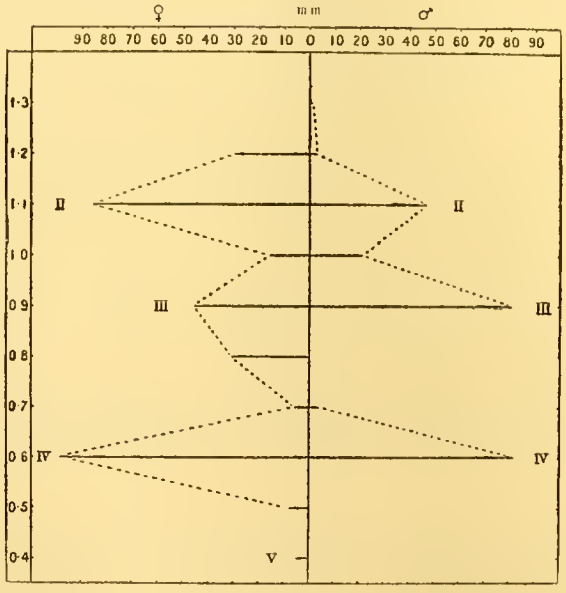
The actual measurements were as follows:—

	♀.	mm.	♂.	
	0	1·3	1	
	29	1·2	3	
Stage II.	86	1·1	47	Stage II.
	16	1·0	21	
	46	0·9	81	Stage III.
Stage III.	31	0·8	0	
	6	0·7	4	
Stage IV.	99	0·6	82	Stage IV.
	8	0·5		
Stage V.	5	0·4		

Table F.—Total specimens measured: 326 ♀ + 239 ♂ = 565.

It is quite possible that the larvæ of less than 0·9 mm. include a few larvæ of *spinifera*, possibly also of *procera*.

Fig. D.



Conchœcia haddoni, Brady & Norman.

The specimens available were very few, but at least four stages were recognisable among the females, and two (I. and III.) among the males. The attribution of some of the smallest specimens (0·7 to 0·4 mm.) was naturally not always assured, but the high position of the right asymmetrical gland seemed to indicate this species.

The specimens were thus distributed:—

	♀.	mm.	♂.
Stage I. Mean, 2·72.	2	3·0	
	1	2·9	
	4	2·8	
	3	2·7	
	6	2·6	
	1	2·5	
		2·1	2 Stage I.
Stage II. Mean, 1·66.	2	1·7	
	1	1·6	
Stage III. Mean, 1·01.	1	1·1	
		1·0	3 Stage III.
Stage IV. Mean, 0·66.	1	0·8	
	6	0·7	
	3	0·6	
	1	0·5	
? Stage V.	? 3	0·4	

Table G.—Total specimens measured: 37+?3 ♀, 5 ♂ = 42+?3.

In the females the usual proportions between the means appear, the second place of decimals being somewhat vague, presumably owing to the paucity of specimens. Thus, 0·62 × 1·64 = 1·01; 1·01 × 1·64 = 1·656; 1·66 × 1·64 = 2·72. The observed mean of 0·66 for Stage IV. is perhaps too high, and the growth-factor employed a little larger than the true factor.

In the males, Stage II. with a mean length probably somewhere about 1·45, was not represented in the collections.

Conchœcia hyalophyllum, Claus.

Four stages were observed; of these only the second, or lower sexual stage, has hitherto been recognised, except by Juday, who gives a length for females of 2·4 mm. without further comment. The first stage was apparently described by Müller under the specific name *lophura*.

The actual measurements were as follows:—

	♀.	mm.	♂.
Stage I. Mean, 2·3.	1	2·5	
		2·3	1 Stage I.
	? 1	2·1	
Stage II. Mean, 1·58.	8	1·7	
	24	1·6	3 Stage II.
	13	1·5	27 Mean, 1·5.
	2	1·4	3
Stage III. Mean, 1·07.	1	1·2	
	8	1·1	7 Stage III.
	5	1·0	1 Mean, 1·08.
		0·7	1 Stage IV.

Table H.—Total specimens measured: 62+?1 ♀; 43 ♂ = 105.

The ratios for Brooks's law come out sufficiently clearly, although the total numbers are small, and in spite of the difficulty of separating this species from *magna* * at the lower stages.

Taking the means as a basis for calculation:

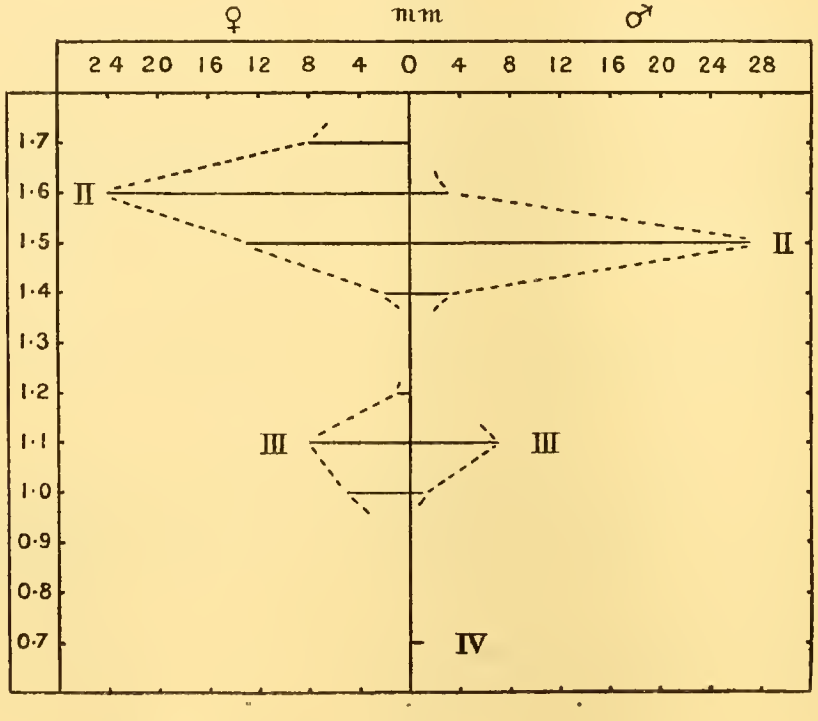
♀ 1·07 × 1·48 = 1·58; 1·58 × 1·48 = 2·33.

♂ 0·77 × 1·40 = 1·078; 1·08 × 1·4 = 1·51; 1·50 × 1·4 = 2·10.

Taking from fig. E the probable extremes of females at Stage II. as 1·3 and 1·8, we get the probable extremes for Stage I. as 1·9 and 2·6; similarly taking the extremes for males as 1·3 and 1·7, we arrive at 1·8 and 2·38 as the probable extremes for Stage I.

This by itself would throw doubt on Juday's record of 2·9 for a male; besides which, he notes only "about twenty pairs" of teeth as the armature of the principal bristle of antenna I. As his brief description is not accompanied by figures, it is not apparent what species was before him, but it was probably not *hyalophyllum*.

Fig. E.



CONCHŒCIA IMBRICATA (Brady pars), Müller.

The actual measurements of this species have been given in the Introduction (p. 225) and need not be repeated here. As already mentioned, on the analogy of other species, there can be little doubt that an older stage exists than any which has yet been recorded with a probable mean length of about ♀ 3·65, ♂ 2·76. The measurements given by Müller for this species seem to have included rostrum and spine.

* It is quite possible that some *hyalophyllum* at Stage III. have been placed with *magna* at Stage III.; it is possible that some *hyalophyllum* Stage IV. have been ranked as "A" larvæ (compare p. 245).

Conchœcia inermis, Claus.

The three specimens captured consisted of two males, 1·9 and 1·5 mm.; and one female, 2·0 mm. The smaller male had not developed secondary sexual characters and was therefore presumably at Stage III.; in this case Stage I., with a male mean presumably about 2·4 mm., has not yet been identified.

Conchœcia loricata, Claus.

It is rather curious that the earlier stages of *loricata* should have been so rarely recognized in the 'Research' collections. It is unlikely that some specimens in which the lateral glands were invisible or inconspicuous were included with Stage II. of *magna*; a close re-investigation of very numerous specimens of the latter with this very object failed to reveal more. As the specimens of adult *loricata* in the comparable epiplankton amounted only to 40, and those of *magna* Stage I. to 136, the penultimate stage of the former is not likely to have been very numerous. On the other hand, if any specimens of Stage IV. and earlier stages were captured, they have probably been put with the "A" larvæ.

The actual measurements were:—

	♀.	mm.	♂.	
Stage I., Mean, 2·58.	1	2·8		
	8	2·7		
	19	2·6		
	10	2·5		
	1	2·4	3	Stage I. Mean, 2·31.
	1	2·3	2	
		2·2	2	
Stage II. Mean, 2·0.	2	2·1		
	3	2·0		
	2	1·9	1	
		1·8	1	Stage II. Mean, 1·75.
		1·7	1	
		1·6	1	
Stage III., Mean, 1·3.	1	1·4		
	1	1·2	2	Stage III. Mean, 1·2.

Table I.—Total specimens measured: 49 ♀ + 13 ♂ = 62.

The specimens at Stage III. are too few to give satisfactory growth-factors.

CONCHŒCIA MAGNA, Claus.

The actual measurements are as follows:—

	♀.	mm.	♂.	
Stage I. Mean, 3·36.	4	3·6		
	26	3·5		
	26	3·4		
	25	3·3		
	9	3·2		
	3	3·1	3	
	3	3·0	23	Stage I.
		2·9	15	Mean, 2·91.
		2·8	22	
Stage II. Mean, 1·88.	1	2·2		
	17	2·1		
	40	2·0	2	
	54	1·9	12	
	64	1·8	78	Stage II.
	16	1·7	40	Mean, 1·77.
	5	1·6	7	
	1	1·5		
		1·4	1	
Stage III. Mean, 1·14.	25	1·3	60	
	193	1·2	136	Stage III.
	216	1·1	17	Mean, 1·22.
	26	1·0	1	

TABLE J.—Total specimens measured: 754 ♀ + 417 ♂ = 1171.

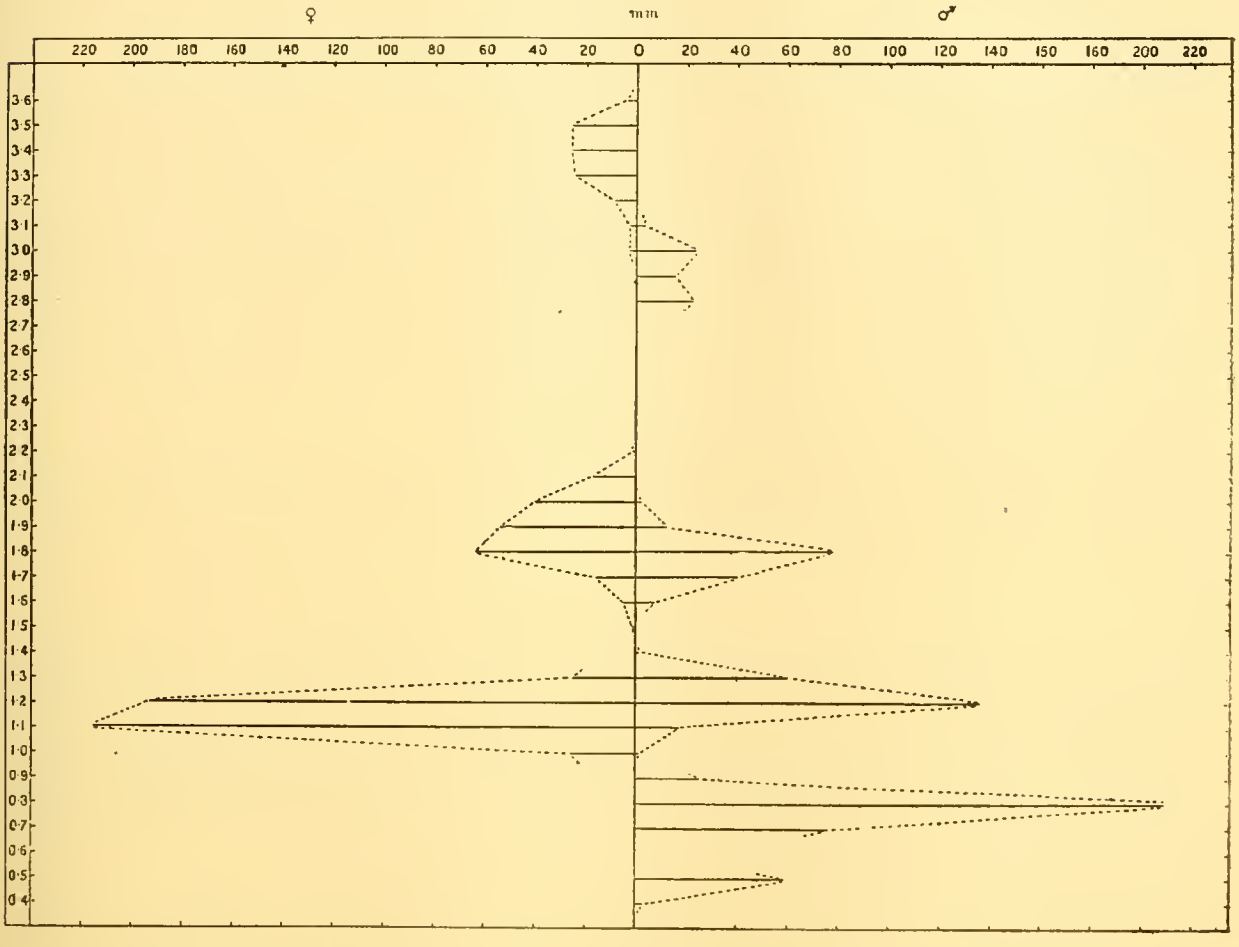
Unusual features of this, the most plentiful species, are the flat-topped curve of Stage I. in the females, and the double-humped curve of Stage I. in the males. These features were consistently noticeable, when the observations were summarized from time to time as the investigation proceeded, and appear to be genuine. There seem to be three possible explanations of these abnormalities. The first (the most obvious) is that I have confused together the successive stages of two parallel species with nearly identical structure: this explanation does not commend itself to me (leaving out of count the care taken over the work), because I do not believe that two such exactly similar species can co-exist in such intimate association in the same locality; this explanation must, however, be borne in mind. A second possibility is that the larger "*macrocheira*" forms may really belong to a different species from the smaller "*magna*" forms. This would imply the very improbable result that of two closely-allied and intimately associated species the one was represented only by Stage I.*, the other only by Stage II. and perhaps smaller stages.

* The observations recorded in the Systematic Part seem to leave no doubt that the Halocypridæ have two stages with secondary sexual characters.

Against both the foregoing possibilities may also be urged the argument from constant association. Of the 65 comparable hauls in the epiplankton, 48 contained what I term *Conchœcia magna* *. Of these 48 hauls, 81 per cent. contained at least two stages, and 45 per cent. contained all three; the association was therefore very constant.

The third explanation—almost the same as the first, but in other words—is that the species is unstable, is beginning to split up into a larger and a shorter race. So long as a species is stable it seems probable that any character measured and plotted graphically

Fig. F.



The two lower curves on the right hand of the abscissa are of both sexes of "A" larvæ mixed.

will yield a curve of frequency with a marked mode; but if the species tends to vary in respect of that character into two races, the curve will ultimately show a double hump with a central depression between the two modes about which the measurements are grouped; the depth of this depression has even been used as an "index of isolation." But before the two races have been so far established as to show the double-humped curve, there will presumably be a transition period at which the curve, instead of presenting a tall mode, will show a flattened apex, and this condition is apparently

* Of the remaining 17, 11 contained Halocyprids but not *magna*.

represented in the female Stage I. of *magna*. Provisionally, therefore, I regard *magna* as exhibiting an early phase of a tendency to split into two races.

When this investigation was begun, it was of course not realized at first to what the measurements of the specimens by sexes would lead. Unfortunately therefore, owing to the probability that one or two other species were included with *magna* in the A larvæ (p. 245), and because my object was merely identification of species with a view to questions of distribution, it did not at that time seem worth while to carry the measurements lower than 1·0 mm., and not even all specimens of that length were carefully recorded, as was the case with the greater lengths. It could not thus early be foreseen that one was thus arbitrarily cutting off the shorter members of Stage III., with the result that the mean calculated on the recorded specimens is necessarily too high. This seems to be shown, at any rate in the females, by dividing downwards, instead of the method of multiplying upwards adopted in other species. By dividing the mean for Stage I. by that for Stage II., $3{\cdot}36 \div 1{\cdot}88 = 1{\cdot}78$ the growth-factor, and $1{\cdot}88 \div 1{\cdot}78 = 1{\cdot}05$ the probable mean for Stage III., whereas my mean is 1·14. As the meaning of the double-humped curve of the males is obscure, one does not know how to handle the figures of Stage I.; treated as in the females, the observed mean of Stage I. gives a probable mean of 1·07 for Stage III., and the ordinate of the lower hump gives a probable mean of 1·12.

It may be possible to sex and measure these smaller specimens later, but at the moment it would delay publication for some months.

There are other features noticeable in these curves which I must leave to better mathematicians than myself to explain.

The A Larvæ.

Only about a quarter of these larvæ were measured, for the reasons already given. They yielded 25 at 0·9 mm., 209 at 0·8, 76 at 0·7, 59 at 0·5, 3 at 0·4 mm. The absence of any specimens at 0·6 seems to cut off those at 0·9, 0·8, and 0·7 as Stage IV., at 0·5 and 0·4 as Stage V. Those at Stage IV. form a good curve of frequency (plotted on the diagram for *magna*), but any difference which may exist between males and females at this stage is of course obscured.

A few specimens of Stage IV. were sexed and measured to a second place of decimals; but against this is not only the uncertainty of the specific determination, but the difficulty of absolute determination of the sex. In some specimens the rudiment of the penis is unmistakable, in others its absence; but in a large number one could not trust one's own decision. So far as it went, the measurement seemed to show a mean of 0·79 for females and of 0·83 for males, which may or may not have been true.

Conchœcia procera, Müller.

As already mentioned (p. 246), Stage I. appears to be lacking in the 'Research' collections, and is perhaps the form named *decipiens* by Müller.

The following numbers were observed :—

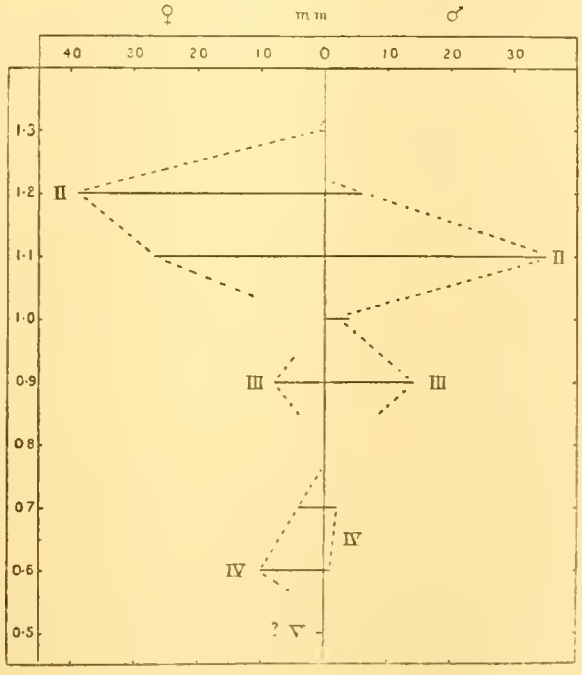
	♀.	mm.	♂.	
Stage II. Mean, 1·16.	1	1·3		
	39	1·2	6	Stage II.
	27	1·1	35	Mean, 1·11.
		1·0	4	
Stage III. Mean, 0·9.	8	0·9	14	Stage III. Mean, 0·9.
		0·8		
Stage IV. Mean, 0·64.	4	0·7	2	Stage IV.
	5	0·6	1	Mean, 0·66.
? Stage V.	1	0·5		

Table K.—Total specimens measured: 85 ♀ + 62 ♂ = 147.

Taking the females first:—0·64×1·36 = 0·87; 0·87×1·36 = 1·18. On morphological grounds the specimen at 0·5 appeared to belong to an earlier stage than those at 0·6 and 0·7; and by the same growth-factor this stage would have a mean at 0·47. Further, 1·18×1·36=1·60, which is the (maximum observed) length given by Müller for female *decipiens*.

In the males there is an overlap of the Stages II. and III. at 1·0, such as has been actually observed in some of the smaller species dealt with in this memoir. Two of the

Fig. G.



four specimens of 1·0 mm. belonged to Stage II., and two to Stage III. We thus get the means given in the foregoing table; the numbers are (as usual!) too small for accuracy: 0·7×1·26=0·88; 0·88×1·26=1·10. As regards *decipiens*, Müller gives a (maximum observed) length of 1·3 mm. for the male of this species, and 1·10×1·26=1·38.

Conchœcia pusilla, Müller, var. major, Müller.

The lengths observed were :—

♀.	mm.	♂.
1	0·8	1
	0·7	3
1	0·6	

Table L.—Total specimens measured : 2 ♀ +4 ♂ = 6.

It may prove to be the case that var. *minor* is only Stage II. of var. *major*.

Conchœcia rhynchena, Müller.

As only one stage with secondary sexual characters in the male was observed (the length of which agreed with Müller's *rhynchena*), the presumption is that an older stage exists, possibly to be found in *kampta* or *tyloda*, as being the only suitable forms of the *mollis* group captured during the cruise. My specimens of these were too few to determine the point.

Measurement of *rhynchena* proper gave the following result :—

	♀.	mm.	♂.	
Stage II. Mean, 2·47.	2	2·6		
	8	2·5		
	2	2·4		
	2	2·3	7	Stage II.
		2·2	1	Mean 2·28.
		1·8	1	Stage III.
Stage III. Mean, 1·60.	1	1·7	1	
	2	1·6		
	1	1·5		
Stage IV. Mean, 1·04.	3	1·1	1	Stage IV.
	1	1·0		
	1	0·9		
Stage V. Mean, 0·70.	2	0·8		
	1	0·7		
	2	0·6		

Table M.—Total specimens measured: 28 ♀ +11 ♂ = 39.

In the females the reaction to a growth-factor is very close :—

$$0{\cdot}7\times1{\cdot}54=1{\cdot}07\ ;\ 1{\cdot}04\ (\text{mean})\times1{\cdot}54=1{\cdot}60\ ;\ 1{\cdot}60\times1{\cdot}54=2{\cdot}46.$$

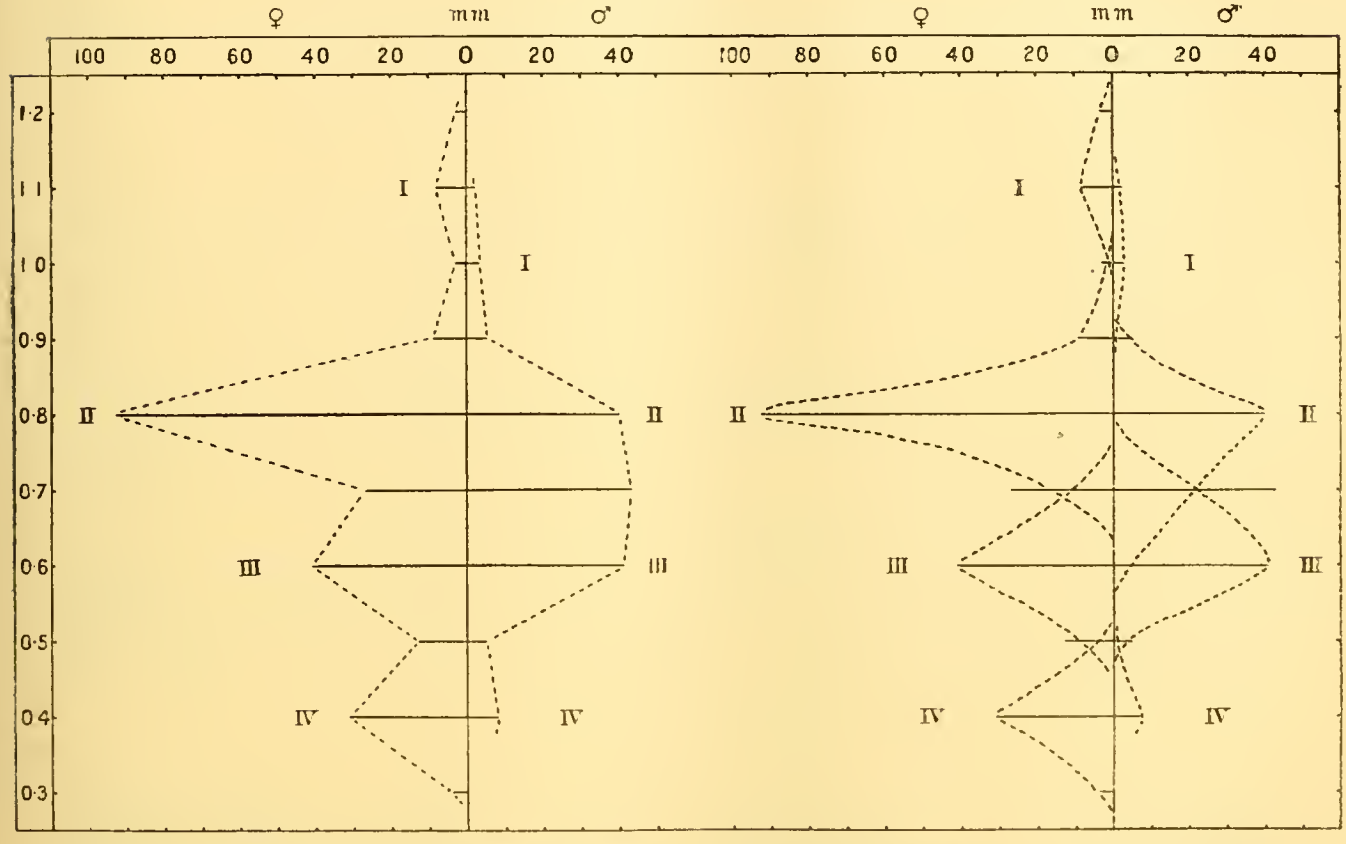
As there are only three males to represent Stages III. and IV., it is useless to discuss their growth-factor, and the numbers in both sexes are too small for the contour of the curves to have any value. They have therefore not been reproduced.

The separation between Stages IV. and V. in females is made on morphological, not statistical grounds.

Conchœcia rotundata, Müller.

This species is so small that my comparatively rough measurements, to the tenth of a millimetre only, fail to bring out clearly the successive stages. Between the lengths of 0·4 and 1·0 mm. there are (apparently) four stages, or three moults within a range of 0·6 mm., and it is obvious that a finer method is required, which was not foreseen at the beginning of the investigation. It is probable, however, that even if measurement to the second place of decimals had been attempted, an overlap of the highest and lowest extremes of successive curves would have occurred (compare the case of *curta*, pp. 260–1).

Fig. H.



The left-hand figure summarises the actual observations; in the right-hand figure an attempt has been made to resolve those ordinates which are due to the overlapping of curves (p. 274).

It is fairly obvious from the diagram that there are four stages on the female side of the scale with maxima at (±) 0·4, 0·6, 0·8, 1·1. Similarly, anatomical investigation showed that the amorphous curve on the male side was really soluble about four maxima at (±) 0·4, 0·6, 0·8, 1·0; the divisions (moults) coming somewhere near 0·45, 0·7, 0·85. The high ordinate at 0·7 on the male side is therefore apparently due to the sum of larger specimens of Stage III., and smaller specimens of Stage II. (lower sexual stage); unfortunately no record was kept of the numbers of these two stages at this length, as the outcome of the investigation was not foreseen at the time. Consequently, only

prolonged study would show how this and similar ordinates are to be divided between the two stages of which they are the sum.

The actual measurements were:—

♀.	mm.	♂.
3	1·2	0
8	1·1	2
3	1·0	3
9	0·9	5
93	0·8	40
27	0·7	43
41	0·6	41
13	0·5	5
31	0·4	7
4	0·3	0

Table N.—Total specimens measured: 232 ♀ + 146 ♂ = 378.

There is a rough way of dealing with these curves, which would probably not commend itself to the statistician: namely, to divide up the doubtful ordinates proportionately to the apparent modes above and below them, on the quite unsupported hypothesis that the lengths of the minor ordinates of the curves vary with their modes. Thus, for example, in the females, the modal ordinate at 0·8 is made of 93 specimens, that at 0·6 of 41 specimens, and 93 : 41 : : 2·2 : 1; consequently the doubtful ordinate of 27 specimens at 0·7 has been divided as 18·5 specimens to the upper curve, and 8·5 to the lower. Similarly, the modal ordinate at 0·6 is made of 41 specimens, and that at 0·4 of 31 specimens; and roughly 41 : 31 : : 4 : 3; consequently the doubtful ordinate at 0·5 has been divided as 7·5 specimens to the upper curve, and 5·5 to the lower. In this way have been obtained the "peeked" curves on the right-hand side of figure H, which represent a *possible* extent of the overlapping.

From the allotment of the doubtful ordinates on these lines came out the following means:—Females at Stage I. 1·11; Stage II. 0·79; Stage III. 0·60; Stage IV. 0·40. Males at Stage I. 1·0; Stage II. 0·77; Stage III. 0·61; Stage IV. 0·41. Now $0{\cdot}42 \times 1{\cdot}39 = 0{\cdot}58$ (0·6); $0{\cdot}58 \times 1{\cdot}39 = 0{\cdot}8$ (0·79); $0{\cdot}8 \times 1{\cdot}39 = 1{\cdot}11$: and $0{\cdot}47 \times 1{\cdot}3 = 0{\cdot}61$; $0{\cdot}61 \times 1{\cdot}3 = 0{\cdot}79$ (0·77); $0{\cdot}79 \times 1{\cdot}3 = 1{\cdot}02$. This is fairly good, considering the all-round possibilities of small errors.

It does not seem possible to get a closer result, without a more refined system of measurement, which, as already pointed out (p. 260), has its own peculiar difficulties. *Rotundata* is so far a more favourable object of study than *curta*, in that its shells are more flattened laterally, and can therefore be much more easily poised in a true profile position

Conchœcia spinifera, Claus.

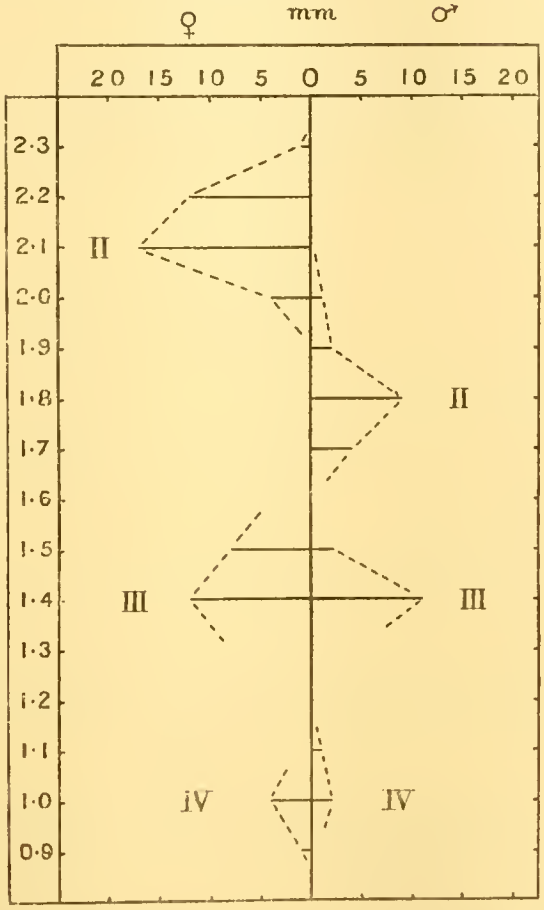
Only three stages were observed, of which only one showed the male with secondary sexual characters.

The following measurements were made:—

♀.	mm.	♂.	
1	2·3		
Stage II. 12	2·2		
Mean, 2·12. 17	2·1		
4	2·0	1	
	1·9	2	Stage II.
	1·8	9	Mean, 1·80.
	1·7	4	
Stage III. 8	1·5	2	Stage III.
Mean, 1·44. 12	1·4	11	Mean, 1·41.
	1·1	1	Stage IV.
Stage IV. 4	1·0	2	Mean, 1·03.
Mean, 0·98. 1	0·9		

Table O.—Total specimens measured: 59 ♀ + 32 ♂ = 91.

Fig. I.



The females, although few, respond well to Brooks's law:—0·98×1·47=1·44; 1·44×1·47=2·11. There were only three males at Stage IV., a number which cannot be expected to yield a satisfactory mean; the mean is too low to fit with the ratios between Stages III. and II.: 1·08×1·30=1·40; 1·40×1·30=1·82.

If the supposition that an older stage exists be correct, its female mean will be about 3·10=2·11×1·47, and its male mean about 2·36=1·82×1·30.

Conchœcia spinirostris, Claus.

= *C. porrecta*, Claus.

The table of measurements given below seems to show two male and two female stages. Both of the male stages exhibited secondary sexual characters, the longer having more teeth on the armature than the shorter; they may safely be placed as Stages I. and II. But according to the rule which seems to hold good in almost all the groups of *Conchœcia* (the *curta*-group excepted, where the males are said to be of the same length as, or even a little longer than, the females), the females at Stages I. and II. are longer than the corresponding males; the presumption therefore is that the females belong to Stages II. and III.

Dr. Müller gives *porrecta* Claus as a synonym for *spinirostris* ("ich halte *C. porrecta* Claus, nur für gestreckte Individuen von *C. spinirostris*"). With this I agree, with the slight correction that I hold *porrecta* as the Stage I. of which *spinirostris* is the Stage II. Of the two names the latter has priority.

As regards the lengths, Claus gives 1·6 mm. without specifying the sex; Müller records 1·1–1·6 for females *, 0·95–1·4 for males. The range between these two extremes is rather large for so small a species, and he probably had both stages before him.

The lengths represented were :—

	♀.	mm.	♂.
		1·3	2 } Stage I. Mean, 1·3.
Stage II. Mean, 1·10.	2	1·2	
	8	1·1	
	1	1·0	3 } Stage II.
		0·9	5 } Mean, 0·93.
Stage III. Mean, 0·75.	?1	0·8	
	?1	0·7	

Table P.—Total specimens measured: 13 ♀ + 10 ♂ = 23.

As regards the relation with *porrecta*—in the females 0·75×1·46=1·09; 1·09×1·46 =1·59, which is just within the range observed by Müller; the two males at 1·3 are also within his limits.

Müller has described and figured (Naples Monograph, p. 183, pl. xxxiv. figs. 1, 2, 3, 5) four young stages of this species, of which the two older at least were males; all are younger than the 'Research' specimens. Measured without the rostrum, they were 0·33, 0·44, 0·59, 0·79 mm. Now 0·33×1·35=0·44; 0·44×1·35=0·589 (0·59); 0·589×1·35= 0·79; these are therefore related as in other species. As already pointed out (pp. 227–8), it is not likely that the rates of growth will be exactly identical in different sea-climates, but my male means (on only ten specimens) yield a growth-factor of 1·39, which is not very far off the other; the two sets of observations only just fail to fit together, the

* Figure measured without rostrum, 1·5 mm.

Biscayan means being just too short for a continuation of the Mediterranean means. The two sets of observations give six stages at least for this species.

Conchœcia zetesios, sp. n.

Only two stages were observed, both of which were female. Their measurements were:—

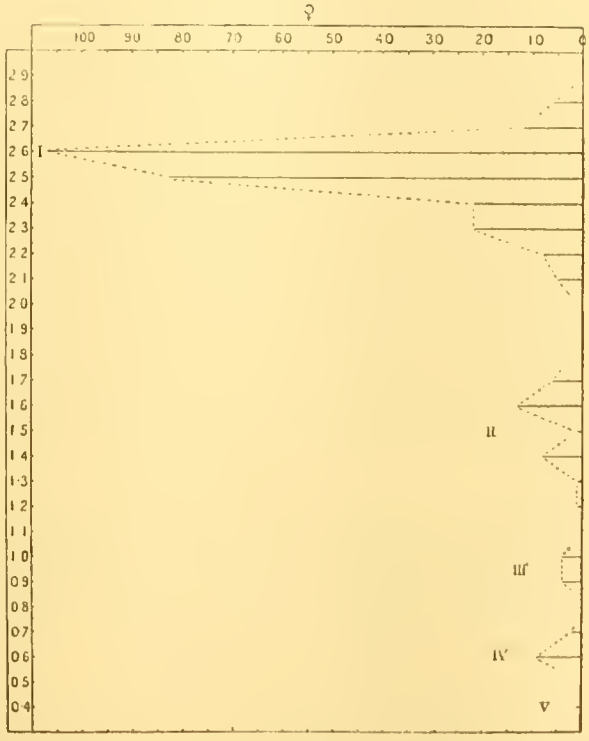
	♀.	mm.
Stage ?I. Mean, 2·42.	1	2·6
	7	2·5
	5	2·4
	5	2·3
Stage ?II. Mean, 1·5.	2	1·5

Table Q.—Total specimens measured: 20 ♀.

Halocypris globosa, Claus.

As regards the males, the lengths of my single specimen (2·1 mm.) and of Dr. Müller's (2·25 mm.) seem to indicate that they belong to the oldest stage, if compared with the mean of females at Stage I.

Fig. J.



The largest females of the 'Research' collections (2·1 to 2·8 mm.) were slightly smaller than those recorded by Müller from the 'Valdivia' expedition (2·6 to 3·0 mm.); but

their curve (fig. J) shows that they all belonged to one stage. At least four, probably five, stages in all were represented.

The actual observations were as follows :—

	♀.	mm.
Stage I. Mean, 2·51.	6	2·8
	12	2·7
	107	2·6
	83	2·5
	22	2·4
	22	2·3
	8	2·2
	5	2·1
Stage II. Mean, 1·54.	6	1·7
	13	1·6
	1	1·5
	8	1·4
	1	1·3
	1	1·2
Stage III. Mean, 0·95.	4	1·0
	4	0·9
Stage IV. Mean, 0·61.	2	0·7
	9	0·6
Stage V. Mean, 0·40.	1	0·4

Table R.—Total specimens measured: 315 ♀ + 1 ♂ = 316.

Stage I. shows a solid, but markedly asymmetrical curve, if the ordinates are simply joined up. Stage II., on the other hand, shows a double-humped curve (for which no morphological reason appeared), and the lower part of the curve of Stage I. could without violence be resolved into a double hump. It is conceivably possible that these abnormalities in the curves may be connected with the rarity of males, if there is any truth in the suggestion on p. 308 that parthenogenesis may occur in this species, since a parthenogenetically produced race often differs markedly in structure and size from a sexually produced race.

Considering the scarcity of the smaller specimens, the response of the mean to Brooks's law is good:—$0{\cdot}37 \times 1{\cdot}62 = 0{\cdot}59$; $0{\cdot}59 \times 1{\cdot}62 = 0{\cdot}95$; $0{\cdot}95 \times 1{\cdot}62 = 1{\cdot}539$; $1{\cdot}54 \times 1{\cdot}62 = 2{\cdot}49$.

The preponderance of Stage I. over the earlier stages is unusual, but the same was shown by *imbricata*.

Owing to the few observations at Stages III., IV., and V., only the two oldest can safely be tested for the extremes of the curve ; and respond well :—$2{\cdot}8 \div 1{\cdot}62 = 1{\cdot}7$; $2{\cdot}1 \div 1{\cdot}62 = 1{\cdot}2$.

Archiconchœcia cucullata, Brady.

Judged by a measurement of his figure, Dr. Müller appears here, as elsewhere, to have included the rostrum and posterior spine in his measurements:— ♀ 1·85–2·2, ♂ 1·8–2·2 mm. The measurable male of my two specimens (32 *l*) was only 1·5 mm. by my method, 1·9 with the rostrum, 2·1 with the rostrum and spine; it fell, therefore, into the same stage as Müller's specimens. The two females measured 1·0 mm. by my method (1·4 with the rostrum and spine), and belonged therefore to an earlier stage, II. or III.

CYPRIDINIDÆ.

Cypridina castanea, Brady.

Apparently three stages, I., II., and IV., were represented in the five specimens; with a growth-factor of 1·5, the lengths 1·8, 2·7 (missing), 4·0, and 6·0 are related as in the other species.

Herrick's Records of Homarus americanus.

It will, I hope, be apparent to the reader that the species just enumerated do respond, however imperfectly, to Brooks's law. In Herrick's great work on the American Lobster (Bull. U.S. Fish Commission for 1895) are given records which enable us to test it in another group of Crustacea. For this purpose his "Record of moults of larval and adolescent stages" (table 34, pp. 176–177) is the most significant. The first three columns in the following table are taken from this record; the fourth column shows the product of the mean length at each moult × a growth-factor 1·14, which is in every case remarkably close to the next highest observed mean length.

Moult.	Number of specimens.	Mean length in mm.	Product.
1	3	8·0	9·1
2	8	9·1	10·3
3	26	10·8	12·3
4	28	12·6	14·3
5	20	14·4	16·4
6	12	16·1	18·3
7	4	18·6	21·2
8	5	21·1	24·0
9	2	24·5	27·9
10	3	28·0	
Total.....	111		

It is quite evident that the same relation exists in the early stages of *Homarus americanus* as in the Halocypridæ. The actual ratio is much lower in the lobster than

in the Ostracods, but it seems likely that the larger and the longer-lived an animal, the less will be its increase at each moult. It is also probable that (as has been shown in some other marine forms) the rate of growth will not be by any means necessarily the same under laboratory conditions as in a state of nature.

The data in table 34 are included with others in Herrick's table 25 (p. 97), where 1·15 fits better as a growth-factor than 1·14; but even this only contains 246 specimens spread over ten moults.

In table 28 (p. 99) Herrick gives the sizes of various parts of the skeleton before, and five days after, a moult; the detailed figures need not be printed here, but show—what, indeed, we knew already—that different parts have each their own growth-rate.

In dealing with a large form like the lobster, a distinction must be drawn between growth-moults at the young stages, and the moults at the later stages. If a lobster continued to moult at the same brief intervals, and to grow by the same increment as did Herrick's larvæ, it would be 10½ inches long at the end of its first year (instead of 2–3 inches), and in five years would be a dangerous monster of portentous size. We know, as a matter of aquarium observation, that the number of moults per annum and the increment at each moult diminish with age. Unfortunately Herrick's observations do not help us to trace this decrease. It is not easy to measure accurately anything so flexible as a many-jointed lobster, especially after moulting, when the connecting membranes have been stretched and the skeleton has been torn across the middle *. This, however, would probably not matter so much if the observations were numerous instead of being scanty and scattered. Hence it is not surprising that the observation in Herrick's tables 20 (82 observations for 14 inches), 32 and 33 (63 observations for 100 mm.), when plotted, failed to show definite groups round medians from which the growth-rate of older stages might be safely inferred.

Records of Carcinus mænas.

Dr. W. T. Calman was good enough to call my attention to a paper † which contained measurements of this species by Mr. H. J. Waddington and the late George Brook, and to place at my disposal some of Mr. Waddington's actual specimens. The latter gentleman measured (apparently not more closely as a rule than 0·25 mm.) the greatest breadth of the cast shells of eleven individuals which he had kept in aquaria. The total observations were only 117, to cover a range in growth of 0·9–62 mm., but seemed to be worth study. When plotted on scale-paper, the observed breadths seemed, at some parts of the scale, to fall into groups round obscure medians; for example, at 9–10, 12–14, 15–17, 18–21 mm. By following out these indications and by working in both directions from them, the following table was obtained. On the immediate left of the vertical line are the means of these vaguely indicated groups; on the right

* It would be safer to measure the live lobster between moults, rather than the cast skin; and in every case to measure also the cephalothorax to the root of the rostrum as well as the total length, carefully noting the sex.

† H. C. Williamson: "Larval and Early Young Stages and Rate of Growth of the Shore-Crab," Ann. Rep. Fishery Board Scotland, xxi. pt. iii. p. 136.

of the line are the successive products, by an empirically-found growth-factor, of means starting from 4·80, the lowest observed mean of the series *.

Mean of	5	specimens of		±5 mm.	=	4·80	4·80 × 1·27	=	6·09
,,	9	,,	,,	±6	,,	6·05	6·09	,,	7·73
,,	8	,,	,,	7–8	,,	7·75	7·73	,,	9·81
,,	9	,,	,,	9–10	,,	9·61	9·81	,,	12·45
,,	11	,,	,,	12–14	,,	12·65	12·45	,,	15·81
,,	9	,,	,,	15–17	,,	16·02	15·81 × 1·23	=	19·44
,,	9	,,	,,	18–21	,,	19·50	19·44	,,	23·91
,,	7	,,	,,	22–26	,,	23·89	23·91	,,	29·40
,,	9	,,	,,	28–33	,,	29·30	29·40		

The close approximation of the two sets of means—those which seemed to come out of Mr. Waddington's observations, and those got by multiplication with a growth-factor—seems to show that the inferred grouping was approximately correct, and that numerous and delicate measurements would show the validity of Brooks's law at the earlier stages. The drop in the growth-factor is interesting, if genuine.

But while the species as a whole thus seems to fall into general line with the observations on Ostracods, the individual specimen (as was also noticed in the American Lobster) does not seem to follow the law with mathematical exactness at each moult. An individual of, say, the mean breadth at a particular stage will not necessarily be of the mean breadth of the subsequent stage; it may be either broader or narrower, so long as it keeps within the extreme limits for that stage. In Mr. Waddington's observations the actual increment at a moult (=the broader ÷ the narrower) varies a good deal in some cases. To some extent this may be due to variations in the aquarium conditions: a large part is probably due to the specimens having been dried before measurement †; part may be set down to the method of measurement (compass and scale, not micrometer-microscope); but a part is probably the animal's own "error."

A most interesting piece of work awaits anyone who will take up the whole question on large Crustacea, with refined systems of measurements of wet specimens. On the whole, a form in which the total length was easily measurable would probably be more reliable than a Brachyuran, in which the breadth of the cephalothorax might possibly be influenced by the necessity for housing a rapidly increasing generative organ at a certain stage.

General Course of the Development of Halocypridæ.

It will have been obvious to those who have followed the descriptions in the Systematic Part, that the morphological changes in the successive moults proceed along fairly well-marked and similar lines in all the species. It is too early as yet to lay

* Below 5 mm. the observations are numerous, but the measurements not delicate enough to separate the various groups; above 33 mm. the observations are few and widely scattered.

† Re-measurement of some of Mr. Waddington's series in the British Museum seemed to show that they had shrunk even since he measured them.

these down precisely, still less can we yet deduce the ancestral form of *Conchæcia*; but they may be outlined as follows:—The shell of the earliest larvæ is very high in comparison to its length, and a steady unbroken curve runs from the postero-dorsal angle to the antennal recess: figure 166 shows a typical early larva. The frontal organ is at first straight, unsegmented, spineless, transparent, and thin-walled; its apex may be either rounded or acute. The first antenna exhibits one bristle and four tubes, even in the younger males. The inner joint of the second antenna has neither central nor basal bristles. No distinction seems to be at first possible between males and females; later, the penis grows out as two rudimentary papillæ, and the three bristles are differentiated from the two tubes in the male antenna i.

As development proceeds the shell becomes (as a rule) longer, but only attains the adult contour gradually, through a succession of moults. The shell of the adult female in the later stages tends to be fuller posteriorly than in the male (that is to say, to project further behind a perpendicular dropped from the postero-dorsal angle), and to have its highest point behind the middle of the length; the shell of the male, speaking generally, has a straighter posterior border. The frontal organ assumes the adult type, if this be highly specialised, by passing through forms which are fairly constant for each stage, but are often highly different from those before and after them. The frontal organ of the adult female is sometimes of a larval type (*spinirostris*); it is rarely so highly differentiated as in the male, but this is sometimes the case (*haddoni*); as a rule it is intermediate in complexity between larval and male types. The principal bristle of antenna i. in the male has at first the sparse irregular minute teeth which are typical of the adult female; it does not assume the definitive secondary male characters (length and armature) until the penultimate Stage II. The dorsal bristle of antenna i. in the female is of comparatively late appearance (generally at Stage II. or ? III.). The inner joint of antenna ii. assumes at first one or two central bristles, later on it may develop basal bristles; the latter may even occur in some females (*haddoni*). The hooks of the male antenna ii. are not developed till Stage II.

IV. FAUNISTIC PART.

Many reports on the various collections made by recent expeditions take for granted that a specimen, merely because it was captured in a closing-net, was necessarily living in the zone explored by the net. This reasoning appears to me most fallacious. When we remember that the abyssal benthos is almost entirely dependent for its food-supply upon the unceasing rain of dead organisms from the upper horizons, it becomes obvious that, always and everywhere in the mid-water, there must be organisms which are dead or dying and sinking to the bottom to furnish this food. Consequently, very strong evidence should be forthcoming, before a species which is plentiful at or near the surface is admitted to be living also in the mesoplankton of its immediate district. This evidence (apart from the specimen being actually observed to be alive when brought on board, which is very unusual in a haul at great depths) can only consist in its being captured often and in considerable numbers from the mid-water. In few cases,

indeed, has such evidence been brought forward. The presumption is always against an animal living under two such totally opposed environments as the epiplankton and deeper mesoplankton, until the contrary has been shown to be probable. Such cases are believed to exist, and three are given below in which apparently the younger stages are epiplanktonic, the older mesoplanktonic; but they are comparatively rare.

Nor can the condition of the tissues be admitted as evidence:—Firstly, because the tissues of indisputably mesoplanktonic animals are sometimes damaged, either by the diminished pressure, or by the chafing together of the sides of a closed net, when being hauled. Secondly, because salt water in bulk at low temperatures is an excellent preservative, and at great depths bacteria are few; the tissues may apparently remain unaltered for a long time after death *.

Brandt and Ostwald have shown how little is the difference between the specific gravities of an organism and of the water, which determines whether an animal floats or sinks; from this it would seem to follow that, as soon as an organism is sickly enough to be unable any longer to keep up the fight against gravity, it will begin to sink, although by no means necessarily dead. The only evidence available, therefore, at present is from the comparative abundance or scarcity of the species at different depths. Hence, when an animal is plentiful in the epiplankton, and shows fairly high averages in the upper mesoplankton, but below that shows only fractional averages per 100 fathoms, it is assumed in the following pages that these fractional averages represent only dead or dying specimens sinking towards the bottom. It is not the actual numerical value of the average that is here significant,—for many of the rarer mesoplanktonic forms show equally small averages,—but the ratio of this average to those obtained at higher levels. As an example may be taken the sudden drop in the averages for *curta* (young stages) below 250–150 fathoms, when compared with the figures for 200–100 and 150–50 fathoms, a drop which is maintained fairly steadily down to 1250–1000 fathoms (p. 284, Pl. 27).

In this part of the memoir, except where otherwise mentioned, all numbers of epiplankton specimens have been treated with the usual time-factors to bring them as far as possible to the standard one hour haul.

HALOCYPRIDÆ.

Conchœcia ametra, Müller.

This species was obviously mesoplanktonic; it occurred at the following depths only:—

Between	400–300	fathoms	in 1	of 3	hauls,	with 0·66	specimens per 100 fathom haul.
,,	500–400	,,	3	,, 3	,,	3·66	
,,	750–500	,,	3	,, 4	,,	0·80	
,,	1000–750	,,	1	,, 5	,,	0·08	

* H. N. Moseley: Notes by a Naturalist on H.M.S. 'Challenger.' Ed. 1892, p. 505.

Conchœcia brachyaskos, Müller.

This appears to have been another deep-water form; it occurred only:—

Between	300–200	fathoms	in 1	of 3	hauls, with	0·33	average specimens per 100 fathom haul.
„	500–400	„	1	„ 3	„	0·33	
„	750–500	„	4	„ 4	„	1·10	
„	1000–750	„	2	„ 5	„	0·24	
„	1500–1250	„	1	„ 2	„	0·40	

Conchœcia curta, Lubbock.

The following table, in three parts, gives the distribution (1) in the epiplankton in the usual manner; (2) of "small" specimens, at 0·8 mm. or less, in the mesoplankton; and (3) of large specimens, at Stage I. of 0·9 mm. or more, in the mesoplankton:—

At	0	fathoms this species occurred in	38	per cent. of	13	hauls, with	4·1	average specimens per hour haul.
	25		58	„	12	„	34·9	
	50		69	„	13	„	11·3	
	75		80	„	10	„	61·3	
	100		82	„	17	„	7·9	
Between	150–50	fathoms young specimens occurred in	1	out of	1	„	7·0	average specimens per 100 fathom haul.
	200–100		3	„	7	„	3·8	
	250–150		3	„	3	„	2·6	
	300–200		1	„	3	„	0·6	
	400–300		1	„	3	„	0·3	
	500–400		2	„	3	„	1·3	
	750–500		3	„	4	„	1·8	
	1000–750		2	„	5	„	0·1	
	1250–1000		2	„	3	„	0·1	
Between	500–400	fathoms Stage I. occurred in	1	„	3	„	0·6	
	750–500		3	„	4	„	1·5	
	1000–750		3	„	5	„	0·4	
	1250–1000		1	„	3	„	0·1	

From this table may be inferred:—(1) That the numerical centre of distribution of the smaller specimens was in the lower part of the epiplankton. Taking the percentage of hauls in which the species occurred as well as the average specimens per hour haul *, one may say that the centre was between 25 and 75 fathoms, probably nearer to 75 than 25. This conclusion is for the whole twenty-four hours, neglecting day and night. The night hauls are analysed below (pp. 285, 303). (2) That the large specimens (0·9 mm. or more), which were only taken below 400 fathoms, were probably at home at those depths, like the larger specimens of *rotundata*. (3) That it is to be noted that there was a very sharp drop in the numbers of small specimens per 100 fathom haul somewhere

* The high values for the total catches at 25 and 75 fathoms, when that at 50 fathoms was comparatively small, have been noted in some other cases. Here the high figure at 25 fathoms is due to two late evening hauls, of 126 and 155 specimens; the remaining ten hauls only produced in all 138 specimens. Compare pp. 302, 303.

about 200 fathoms; taking this in combination with (2), I infer that these smaller specimens below 200 fathoms were either dead, dying, or sinking to complete their last moult to Stage I.

Further, it would seem that, though a few specimens occurred as high as the surface and throughout the epiplankton by day, 4.0 A.M.–7.0 P.M., yet the majority of specimens lived below 100 fathoms, and only rose into the epiplankton by night, 7.0 P.M.–4.0 A.M. Analysis of the upper hauls yielded the following result:—

At	0	fathoms the average catch per hour was		6·0	by day,	1·2	by night.
	25	„	„	0·1	„	69·6	„
	50	„	„	5·5	„	18·1	„
	75	„	„	15·3	„	81·0	„
	100	„	„	4·1	„	12·2	„

And, without insisting too strongly on the individaul figures, there can be little doubt that, taken as a whole, they show a far greater population by night than by day.

In summary, it appears probable that the younger stages were essentially of the epiplankton and upper mesoplankton between 0 and 200 fathoms, with a night centre of distribution at 25–75 fathoms; but the older stages were purely mesoplanktonic *, with a maximum between 750–500 fathoms.

The curious rise in the number of small specimens between 400–750 fathoms will be discussed later (p. 297). The whole distribution is very like that of *rotundata* (p. 293).

The specimens at or near the surface were too few and too inconstant to afford any evidence for or against reaction to rain, &c.

Conchœcia daphnoides, Claus.

At	0	fathoms this species occurred in	0	per cent. of 13	hauls, with	0·0	average specimens per hour haul.
	25		8	„	12	„	0·6	
	50		23	„	13	„	11·8	
	75		50	„	10	„	2·2	
	100		35	„	17	„	1·0	
Between	200–100		0	out of	7	„	0·0	average specimens per 100 fathom haul.
	250–150		0	„	3	„	0·0	
	300–200		2	„	3	„	0·6	
	400–300		2	„	3	„	2·3	
	500–400		2	„	3	„	2·0	
	750–500		3	„	4	„	0·8	
	1000–750		2	„	5	„	0·4	
	1250–1000		0	„	3	„	0·0	
	1500–1250		1	„	2	„	0·2	

The distribution presents some curious features. In the first place, all the epiplankton captures were at night, except for a single specimen from 100 fathoms at mid-day.

* Of course if an adult lives at great depths, young specimens probably can also exist there, but it does not follow that they do so.

Secondly, of the 235 specimens actually captured, no less than 65 per cent. were taken in two hauls on a single night (30 *l*, 31 *b*, 50 fms.), forming a veritable swarm. The remaining epiplankton specimens were scattered fairly evenly over the night hauls—in 5 out of 7 night hauls at 75 fathoms, in 6 out of 8 night hauls at 100 fathoms. Thirdly, the steady occurrences between 1000 and 200 fathoms seem to point to the species being mesoplanktonic, although it was missed altogether between 200 and 100 fathoms; but, except for the two hauls already mentioned, it was nowhere so plentiful nor so regularly captured in the epiplankton as that one should expect to find numerous corpses in deep water.

In short, *daphnoides* was in the epiplankton practically by night only, was missed between 250 and 100 fathoms, and reappeared between 1000 and 300 fathoms. It seems almost inconceivable that the upper specimens at night retired to 300 fathoms by day and returned in the evening: muscular effort seems inadequate, and we do not know to what extent and by what methods a Crustacean can alter its specific gravity. A possible clue is given by the fact that of the 235 specimens captured all were at the oldest stage except one single one: this implies that breeding had not taken place in that water for some time past; it is conceivable that a mass of the specimens had risen to breed, in the way suggested by Chun and others for certain groups. But the species was nowhere plentiful in the mesoplankton, and may simply have been missed in the hauls between 250 and 100 fathoms, in the ordinary run of chances, since each haul only filtered theoretically 11–12 cubic feet of water.

Conchœcia elegans, Sars.

		fathoms this species occurred in						average specimens per hour haul.
At	0		0	per cent. of	13	hauls, with	0·00	
	25		25	„	12	„	0·75	
	50		46	„	13	„	6·76	
	75		50	„	10	„	36·40	
	100		52	„	17	„	4·64	
Between	200–100		4	out of	7	„	0·85	average specimens per 100 fathom haul.
	250–150		3	„	3	„	2·33	
	300–200		1	„	3	„	1·00	
	400–300		1	„	3	„	0·33	
	500–400		1	„	3	„	0·33	
	750–500		2	„	4	„	0·30	
	1000–750		1	„	5	„	0·08	

Of the 582 specimens actually captured in the epiplankton (or 540 when treated with the time-factors) only two specimens were taken in daylight. This seems to show that the species as a whole rises by night and sinks by day. But it does not appear that it extends to such depths as do some species; judged by the "average specimens per 100 fathom haul" of the foregoing table, one would not infer that it was living deeper than 300 fathoms, and 250 fathoms is probably nearer the mark.

As with *daphnoides*, the majority of the specimens came from two hauls at the same depth on one night: but they were two nights later than the big hauls of *daphnoides*,

25 fathoms lower, and something like fifteen minutes of latitude away; the actual numbers were 193 specimens from 32 *m*, and 154 from 32 *o*, making about 55 per centum of the total specimens of this species captured.

Conchœcia haddoni, Brady & Norman.

At	0	fathoms this species occurred in	0 per cent. of 13 hauls with			0·00	average specimens per hour haul.
	25		16	„	12	„	0·33
	50		15	„	13	„	0·69
	75		50	„	10	„	1·50
	100		35	„	17	„	0·70

A single specimen also occurred at midnight at the surface in a non-comparable haul, and other single specimens between 350–0 and 1250–0 fathoms. It was not captured once in a closing-net. The species was obviously epiplanktonic, with a centre at about 75 fathoms.

Conchœcia hyalophyllum, Claus.

As already mentioned (p. 266 note), it is possible that some specimens of this species have been placed under *magna*. The numbers of occurrences and actual numbers of specimens captured may therefore perhaps be too small, but they are probably correct in proportion for the various depths.

At	* 0	fathoms this species occurred in	7 per cent. of 13 hauls, with			0·30	average specimens per hour haul.
	25		8	„	12	„	0·08
	50		7	„	13	„	0·15
	75		40	„	10	„	2·10
	100		29	„	17	„	2·29
Between	200–100		1	out of	7	„	0·57
	250–150		1	„	3	„	0·33
	300–200		1	„	3	„	0·66
	400–300		0	„	3	„	0·00
	500–400		1	„	3	„	0·66
	750–500		3	„	4	„	0·60
	1000–750		3	„	5	„	0·32
	1250–1000		1	„	3	„	0·13

The recorded specimens are by no means numerous at any depth, but they are widely and almost consistently distributed vertically, down to the zone 1250–1000 fathoms. They are too scarce in the upper strata for the idea that the mesoplanktonic specimens were merely epiplanktonic corpses; this is all the more potent an argument because every one of the recorded occurrences in the epiplankton is nocturnal, that is between 7.0 P.M. and 4.0 A.M. The species therefore had apparently much the same distribution as *imbricata*; that is, it was a mesoplanktonic form, coming to the epiplankton at night; its plurimum distribution when there was at 75–100 fathoms.

* Two specimens were also taken in 33 *b*, which has been omitted as non-comparable.

It is noticeable that the specimens of Stage I. were from nets lowered to at least 350 fathoms: 34 *f*, 750–500; 23 *a* (the doubtful female), 1000–750; and 36 *l*, 350–0 fathoms. As the numerous captures which have hitherto been made from the Atlantic were always of Stage II., it seems likely that the oldest stage is only to be found in deep water.

Conchœcia imbricata (Brady pars), Müller.

At	50		7 per cent. of	13	hauls, with	0·07	average
	75		30	„	10	„ 2·20	specimens
	100		35	„	17	„ 1·52	per hour haul.
Between	200–100	fathoms this species occurred in	0	out of	7	„ 0·00	
	250–150		0	„	3	„ 0·00	average
	300–200		1	„	3	„ 1·00	specimens per
	400–300		3	„	3	„ 1·66	100 fathom
	500–400		2	„	3	„ 1·00	haul.
	750–500		1	„	4	„ 0·40	

This species was plentiful at no depth; it failed at 0 and 25 fathoms. The single specimen captured at 50 fathoms was only 1 mm. long, but there did not seem to be any general indication that any stage had a preference for any particular level.

It appears obvious from the table that *imbricata* was not present at all in the upper epiplankton, but that it extended at least to 500 fathoms. In such a case as this, where the species is uncommon in the epiplankton, it is fairly certain that the mesoplanktonic specimens were living at the lower levels and were not merely falling corpses.

It is further of interest to note that all the ten occasions on which it was captured in the epiplankton were between 7.0 P.M. and 4.0 A.M.; this strongly suggests a rise from deeper water at night; these 10 hauls form 32 per cent. of the comparable night hauls, and are therefore a fair test of the point.

The horizontal distribution in the epiplankton was quite local, even in the small area studied: the stations were all in the southern part of the area.

Although this species failed in the hauls with closing-nets between 250 and 100 fathoms, it was captured in the serial hauls 36 *g*, *h*, *k* (200–0, 250–0, 300–0 fathoms) in such numbers as to ensure that the specimens were not merely caught in the hauling of the nets to the surface.

Conchœcia inermis, Claus.

This species was observed only in a serial haul, 36 *l* (350–0 fathoms), and no conclusion as to its horizon can be made.

Conchœcia kampta, Müller.

This was represented only by two males of the same stage, which were taken in two hauls (22 *b*, 34 *e*) between 750–500 fathoms. The species was presumably purely mesoplanktonic.

Conchœcia loricata, Claus.

At	50	fathoms this species occurred in	23 per cent. of	13	hauls, with	0·30	average specimens per hour haul.
	75		60 „	10	„	0·60	
	100		47 „	17	„	1·58	
Between	150–50		1 out of	1	„	1·00	average specimens per 100 fathom haul.
	200–100		1 „	7	„	0·14	
	250–150		0 „	3	„	0·00	
	300–200		1 „	3	„	0·33	
	400–300		1 „	3	„	0·66	
	500–400		1 „	3	„	1·33	
	750–500		1 „	4	„	0·10	

It occurred also in three non-comparable hauls, one of which was at 100 fathoms.

Unlike some species already dealt with, *loricata* was found in the epiplankton by day as well as by night. Of the 17 epiplanktonic occurrences, 8 were during daylight, and contained 24 of the 37 specimens (numbers multiplied by time-factor). The epiplanktonic specimens were comparatively so few that the mesoplanktonic specimens cannot be dismissed as dead or dying. This species would therefore seem to have belonged to the lower epiplankton and upper mesoplankton, with a maximum at 100 fathoms, and apparently another at 500–400 fathoms. The mesoplanktonic specimens were on the whole smaller than the epiplanktonic.

Conchœcia magna, Claus.

At	0	fathoms this species occurred in	38 per cent. of	13	hauls, with	0·84	average specimens per hour haul.
	25		41 „	12	„	1·83	
	50		92 „	13	„	22·38	
	75		90 „	10	„	17·00	
	100		100 „	17	„	34·11	
Between	150–50		1 out of	1	„	6·00	average specimens per 100 fathom haul.
	200–100		7 „	7	„	2·85	
	250–150		3 „	3	„	1·00	
	300–200		1 „	3	„	0·33	
	400–300		2 „	3	„	0·66	
	500–400		2 „	3	„	0·66	
	750–500		4 „	4	„	1·10	
	1000–750		3 „	5	„	0·10	
	1250–1000		0 „	3	„	0·00	
	1500–1250		1 „	2	„	0·20	

From this general table it would seem that the species lived in considerable numbers in the lower epiplankton (50–100 fathoms) and upper epiplankton (100–200 fathoms). Below 200 fathoms the captures are so few in numbers that, considering the very large numbers near the surface, we may with safety attribute them to dead or dying

specimens. The slight rise in "average specimens per 100 fathoms" at 750-500 fathoms has been noticeable in other species, and will be discussed later (p. 297).

The following table gives the comparative prevalence by day and by night:—

At 0	fathoms this species occurred in	62	per cent. of 8	hauls by	day,	with	1·37	average specimens per hour haul.
		0	,, 5	,,	night.	,,	0·00	
25		50	,, 6	,,	day,	,,	1·16	
		33	,, 6	,,	night,	,,	2·50	
50		85	,, 7	,,	day,	,,	8·57	
		100	,, 6	,,	night,	,,	38·50	
75		100	,, 3	,,	day,	,,	16·33	
		85	,, 7	,,	night,	,,	17·28	
100		100	,, 9	,,	day,	,,	24·88	
		100	,, 8	,,	night,	,,	44·50	

At 50 or more fathoms the chances of capturing the species (percentage of hauls) were approximately equal by day and by night, and the greater number of specimens was also below this depth both by day and night. The small but uniform excess of specimens taken by night at 50, 75, and 100 fathoms over those taken at the same depths by day seems to suggest a slight nocturnal movement upwards of specimens from the upper mesoplankton.

The total numbers at the surface and 25 fathoms are so small that it does not seem profitable to discuss the reaction to rain, &c.

With the large numbers of specimens available it seemed advisable to ascertain whether a particular stage exhibited a preference for any particular horizon in the epiplankton. The following table shows under I., II., and III. the percentage of the total specimens of that stage which was found at each depth; unlike the other tables, this gives (for obvious reasons) the actual numbers observed, not multiplied by a time-factor:—

		I.	II.	III.
At	0 were captured	3·6	0·9	0·4
	25 ,,	3·6	0·9	2·1
	50 ,,	27·9	13·8	31·2
	75 ,,	5·8	12·8	16·7
	100 ,,	58·8	71·3	49·3
		99·7	99·7	99·7

This table gives an interesting but negative result, in that there seems to have been no stratification according to stages; all three stages were most plentiful at 100 fathoms, and more so at 50 than at 75 fathoms.

As with some other species which have been worked out on similar lines, the horizon of 75 fathoms shows lower figures in the tables than are found at 50 and 100 fathoms. The reason for this is still to seek; but the observation is interesting, as contradicting the suggestion (which has more than once been made to me) that greater numbers at lower depths in the epiplankton are due to specimens caught while hauling the open

net to the surface from the horizon where it has been fishing; were this so, the results at 75 fathoms should be intermediate between those at 50 and 100 fathoms; as a fact, they are often not so. The same relation has been noticed in some species at a higher level, 25 and 75 fathoms having a preponderance of specimens over 50 fathoms. A possible explanation is suggested on p. 303.

The A Larvæ.

Though the exact attribution of the individual specimens may in some cases be uncertain, there can be little doubt that the majority of these larvæ can be safely assigned to *magna*, apart from the morphological grounds dealt with in the Systematic Part. Of the total specimens * of the five species likely to have been represented by larvæ of this general type, *magna* formed 87 per cent., *zetesios* 1, *hyalophyllum* 6, *loricata* 3, *spinirostris* 1 per cent. Under the reasonable supposition that the relation of larvæ to adults is anything like proportional in the different species, it is probable that by far the larger number belonged to *magna*. With the reservation that a small percentage may have belonged to other species, the A larvæ are here attributed to *magna* for statistical purposes.

At	0	fathoms this species occurred in	23 per cent.	of	13	hauls, with	0·76	average specimens per hour haul.
	25		75	„	12	„	7·16	
	50		92	„	13	„	16·46	
	75		90	„	10	„	53·10	
	100		88	„	17	„	19·70	
Between	150–50		1	out of	1	„	5·00	average specimens per 100 fathom haul.
	200–100		6	„	7	„	5·71	
	250–150		2	„	3	„	1·66	
	300–200		3	„	3	„	1·33	
	400–300		1	„	3	„	1·00	
	500–400		1	„	3	„	0·33	
	750–500		2	„	4	„	0·30	
	1000–750		1	„	5	„	0·08	
	1250–1000		0	„	3	„	0·00	
	1500–1250		1	„	2	„	0·20	

The distribution appears to be much the same as that of *magna*: that is to say, these larvæ were plentiful in the epiplankton and down to about 200 fathoms; below this depth their scarcity, as compared with the large numbers at higher levels, probably indicates that the few specimens captured were dead or dying.

But there is a slight difference from the corresponding table in *magna*, in that a distinct plurimum is observed at 75 fathoms; further, the slight rise in population at about 750–500 fathoms which is noticeable in several other species is not clear here, though there is a marked drop in the captures below 750 fathoms.

* Actual numbers, comparable hauls, epiplankton.

The next table records the distribution of these larvæ by day and by night in the epiplankton :—

At	0	fathoms these larvæ occurred in	37	per cent. of 8	hauls by day,	with 1·25	average specimens per hour haul.
	25		00	„ 5	„ night,	„ 0·00	
			83	„ 6	„ day,	„ 2·33	
	50		66	„ 6	„ night,	„ 12·00	
			85	„ 7	„ day,	„ 7·42	
	75		100	„ 6	„ night,	„ 27·00	
			100	„ 3	„ day,	„ 23·66	
	100		85	„ 7	„ night,	„ 65·71	
			77	„ 9	„ day,	„ 10·22	
			100	„ 8	„ night,	„ 30·37	

With them, as with *magna*, there is an increase in the night population at 25, 50, 75, and 100 fathoms, which seems to point to a nocturnal rise of specimens from 200–100 fathoms. The plurimum at 75 fathoms is more marked by night than by day.

Conchœcia procera, Müller.

At	0	fathoms this species occurred in	7	per cent. of 13	hauls, with	0·15	average specimens per hour haul.
	25		0	„ 12	„	0·00	
	50		0	„ 13	„	0·00	
	75		50	„ 10	„	1·10	
	100		70	„ 17	„	4·41	
Between	150–50		1	out of 1	„	4·00	average specimens per 100 fathom haul.
	200–100		6	„ 7	„	2·00	
	250–150		1	„ 3	„	0·33	
	300–200		1	„ 3	„	0·33	
	400–300		0	„ 3	„	0·00	
	500–400		0	„ 3	„	0·00	
	750–500		1	„ 4	„	0·10	

The species was, comparatively speaking, rare; it was taken only once at the surface, never at 25 or 50 fathoms. The table shows a plurimum for the epiplankton at 100 fathoms, and that the species extended in fair numbers into the 200–100 fathom zone. The single specimens and fractional averages below this zone may be attributed to dead or dying specimens. Analysis of the epiplankton captures showed no trace of a nocturnal rise from the upper mesoplankton.

Conchœcia pusilla, Müller, var. major, Müller.

This species was only captured

Between	750–500	fathoms in	3	out of 4	hauls, with	0·50
	1000–750	„	1	„ 5	„	0·08

average specimens per 100 fathom haul.

Conchœcia rhynchena, Müller.

Between	300–200	fathoms this species occurred in	1 out of 3 hauls, with	0·33
	400–300		2 „ 3 „	1·33
	500–400		3 „ 3 „	3·00
	750–500		2 „ 4 „	1·20
	1000–750		1 „ 5 „	0·24

average specimens per 100 fathom haul.

This forms a typical mesoplanktonic distribution, yielding a regular spindle.

Conchœcia rotundata, Müller.

The following table shows the distribution (1) in the epiplankton, (2) of specimens at Stage II. or earlier in the mesoplankton, and (3) of specimens at Stage I. in the mesoplankton :—

At	0	fathoms this species occurred in	15 per cent. of 13 hauls, with		0·1
	25		33 „ 12 „		1·9
	50		38 „ 13 „		4·6
	75		90 „ 10 „		62·2
	100		88 „ 17 „		14·3

average specimens per hour haul.

Between	150–50	fathoms young specimens occurred in	1	out of 1 „	6·0
	200–100		4	„ 7 „	4·8
	250–150		2	„ 3 „	0·6
	300–200		1	„ 3 „	0·6
	400–300		0	„ 3 „	0·0
	500–400		0	„ 3 „	0·0
	750–500		2	„ 4 „	0·3
	1000–750		2	„ 5 „	0·1
	400–300	fathoms Stage I. occurred in	2	„ 3 „	1·0
	500–400		2	„ 3 „	1·6
	750–500		4	„ 4 „	0·5
	1000–750		3	„ 5 „	0·4
	1250–1000		0	„ 3 „	0·0
	1500–1250		1	„ 2 „	0·4

average specimens per 100 fathom haul.

The general distribution was that of *curta*. We have a species which had a plurimum at about 75–100 fathoms, but extended to the surface. Down to about 200 fathoms the smaller specimens, Stage II. or younger, were fairly plentiful. Their lower limit would seem to be at about that level, and I regard at any rate most of the few small specimens caught at greater depths as dead or dying, or perhaps sinking for their last moult. On the other hand, the larger specimens at Stage I. seem to attain a plurimum between 500 and 300 fathoms. It is not suggested that no large specimen ever rises into the epiplankton, but that the oldest stage as a whole seeks deeper water.

The specimens at 0, 25, and 50 fathoms were too few to give any indication of diurnal oscillation or of reaction to rain. But

At	75	fathoms	the average catch was	35·00	specimens	by day,
„	„	„	„	73·85	„	night,
100	„	„	„	8·66	„	day,
„	„	„	„	20·75	„	night,

showing a rise in the population at both horizons by night, and a plurimum at 75 fathoms for both day and night.

Conchœcia spinifera, Claus.

At	50	fathoms this species occurred in	15	per cent. of	13	hauls, with	0·46	average specimens per hour haul.
	75		40	„	10	„	2·30	
	100		29	„	17	„	2·00	
Between	200–100		1	out of	7	„	0·14	average specimens per 100 fathom haul.
	250–150		3	„	3	„	1·00	
	300–200		2	„	3	„	0·66	
	400–300		2	„	3	„	1·66	
	500–400		1	„	3	„	0·33	
	750–500		3	„	4	„	0·40	
	1000–750		1	„	5	„	0·08	

All the epiplanktonic specimens were taken by night, which points to a nocturnal rise from the upper mesoplankton. The species was so scarce at all depths that it is doubtful where its plurimum (if any) was to be found; perhaps somewhere between 400 and 150 fathoms.

Conchœcia spinirostris, Claus.

= *C. porrecta*, Claus.

The total number of specimens is so small that to reduce them to the usual "average specimens per hour haul" would be rather a farce.

At	0	fathoms this species occurred in	1	out of	13	hauls, with	0	by day	+1	by night	=1 specimen.
	25		1	„	12	„	1	„	+0	„	=1 „
	50		5	„	13	„	2	„	+5	„	=7 specimens.
	75		4	„	10	„	4	„	+3	„	=7 „
	100		5	„	17	„	6	„	+1	„	=7 „

The table* shows the rarity at all depths. As there were so few specimens in the epiplankton, it is not surprising that none were captured in the mesoplankton.

* Actual numbers; not multiplied by a time-factor.

Conchœcia tyloda, Müller.

One unmistakeable specimen occurred in 24*a* (1250–1000 fathoms); and a pair of empty shells which seemed also attributable to this species was found in 30*i* (1500–1250 fathoms).

Conchœcia zetesios, sp. n.

The specimens were so few that they are better not expressed in the usual averages. A plurimum (if the word can be used of so small a number) was, however, noticeable at 100 fathoms. The species would seem to have inhabited the lower epiplankton and upper mesoplankton. Only three specimens were taken by night.

At	50	fathoms this species occurred in	2 out of 13 hauls, with 4 specimens *.
	75		2 „ 10 „ 2 „
	100		3 „ 17 „ 11 „
Between	200–100		1 „ 7 „ 1 „
	300–200		1 „ 3 „ 1 „

Halocypris globosa, Claus.

The following table shows the distribution of this species in the epiplankton; it has clearly a centre in the lower epiplankton, the specimens were thickest at 50 fathoms, the occurrences most numerous at 50, 75, and 100 fathoms :—

At 0	fathoms this species occurred in	15 per cent. of 13 hauls, with	0·5	average specimens per hour haul.
25		58 „ 12 „	2·2	
50		84 „ 13 „	14·9	
75		80 „ 10 „	9·7	
100		88 „ 17 „	3·6	

Below 100 fathoms only one specimen was captured, the single male at 750–500 fathoms.

This is remarkable because the species was common in the epiplankton, and many specimens must die, yet not a single one appeared in the closing-nets. This fact suggests that a comparatively large form (84 per cent. of the specimens were over 2 mm. in length), when dead and sinking, is more likely to be snapped up for food in the dark, than a tiny form such as *curta* or *rotundata*; this seems reasonable, because there is more of it to be touched or smelt.

* Actual numbers; not multiplied by a time-factor.

At 0	fathoms this species occurred in	25	per cent. of	8	hauls by	day, with	0·8
25		00	„	5	„	night, „	0·0
		66	„	6	„	day, „	2·0
50		50	„	6	„	night, „	2·5
		85	„	7	„	day, „	10·0
75		83	„	6	„	night, „	20·6
		100	„	3	„	day, „	28·3
100		85	„	7	„	night, „	1·7
		88	„	9	„	day, „	5·1
		87	„	8	„	night, „	2·0

average specimens per hour haul.

It would seem possible that the plurimum at 75 fathoms by day rose to 50 fathoms at night.

Archiconchœcia cucullata, Brady.

This species occurred in the following hauls:—32 *l* (400–300 fathoms), 34 *e* (750–500 fathoms), 27 *b* (1250–1000 fathoms), 27 *a'* (1250–0 fathoms). It was obviously a member of the deeper mesoplankton.

CYPRIDINIDÆ.

Cypridina castanea, Brady.

This species occurred in the following hauls:—32 *m* (75 fathoms), 32 *p* (100 fathoms), 36 *g* (200–0 fathoms), and 36 *h* (250–0 fathoms). It is worth noting that the two epiplanktonic captures were between 10.30 P.M. and 1.30 A.M.

Gigantocypris pellucida, Müller.

The two captures of this species give the first definitive evidence that it is a deep-water form, previous captures having been made with open vertical nets. Both are very deep: 31 *d* at 1000–750 fathoms, and 26 *b* at 2000–1500 fathoms.

The Vertical Distribution of the Ostracoda as a whole.

The first point to be considered is the general distribution of the planktonic Ostracoda (practically that of the Halocypridæ) during the period and through the area investigated. This can best be grasped by taking the comparable hauls at each depth, and the average specimens per hour or per 100 fathoms which they yielded. To the specimens recorded in the General List (pp. 312–313) have been added all specimens which were too much broken for identification, a few indeterminable larvæ, and the seven species which occurred so rarely as not to have been printed in the general list.

Hauls 27 *a* and 36 *l* are of course omitted. The table following gives these general results; they are diagrammatically expressed in figure K, p. 298.

At	0	fathoms in	13	hauls were	8·15	average specimens per hour haul.
	25	„	12	„	50·00	
	50	„	13	„	92·23	
	75	„	10	„	262·00	
	100	„	17	„	100·58	
Between	150–50	„	1	„	30·00	average specimens per 100 fathom haul.
	150–100	„	1	„	28·00	
	200–100	„	7	„	21·85	
	250–150	„	3	„	10·00	
	300–200	„	3	„	11·33	
	400–300	„	3	„	13·33	
	500–400	„	3	„	20·33	
	750–500	„	4	„	13·90	
	1000–750	„	5	„	3·76	
	1250–1000	„	3	„	0·80	
	1500–1250	„	2	„	1·40	
	2000–1500	„	2	„	0·10	

The table shows in the first place how admirably adapted are Ostracods for the study of oceanic planktology, by their great numbers at even considerable depths. The next thing obvious is the plurimum at 75 fathoms, as compared with the other epiplanktonic horizons studied; from this the distribution tapers upwards to the surface, downwards to about 250 fathoms.

Less obvious, but apparently representing a real fact, is the broadening out of the distribution spindle (fig. K) between 750 and 300 fathoms, to which reference has been made in the discussion of the distribution of several species; the same thing has been noticed in some earlier parts of this series of papers. This puzzling phenomenon may perhaps ultimately find its explanation from Ostwald's recent work. He has shown that the viscosity (innere Reibung) of sea-water increases very rapidly with diminishing temperature or increasing specific gravity; and he and Brandt have both shown how very slight a difference in specific gravity determines whether an organism shall sink or float. It seems possible that for each species, according to its own specific gravity and contour-resistance (Form-Widerstand*), there will come a point in its fall towards the bottom, when dead or dying, where the increased specific gravity of the water (due to pressure) and the much diminished temperature produce a viscosity which so nearly balances the excess-weight of the animal over that of water (Uebergewicht) as to reduce the velocity of descent; these points, or rather levels, will be different for different species, and will together form a zone where dead and dying animals are more abundant than they are above that zone.

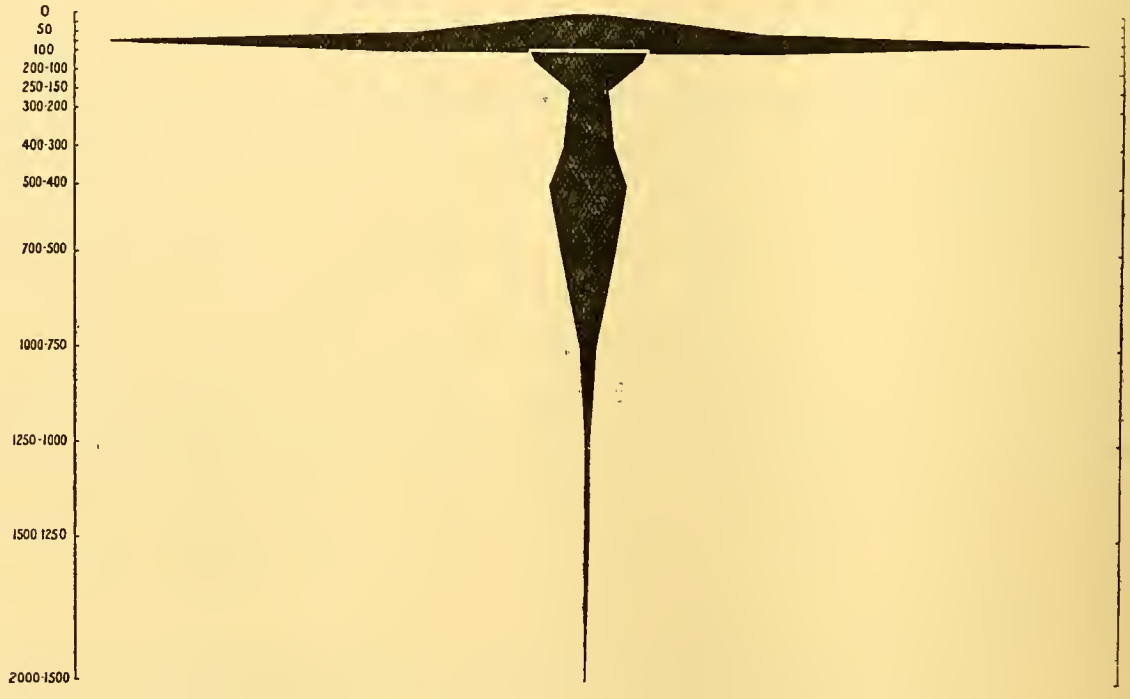
* For the explanation of the terms and for the whole question see Ostwald: "Theoretische Planktonstudien," Zoologische Jahrbücher, Abtheil. Systematik, Band xviii. S. 1–62.

In that zone there would be a happy hunting-ground, a region of maximum food-supply, for the purely mesoplanktonic species. Taking the species, and the oldest stages of species, which were recognised above as having been purely mesoplanktonic during the Biscayan cruise *, we find that

the plurimum of	*ametra*	was at	500–400	fathoms.
„	*brachyaskos*	„	750–500	„
„	*curta*, Stage I.	„	750–500	„
„	*pusilla*	„	750–500	„
„	*rhynchena*	„	500–400	„
„	*rotundata*, Stage I.	„	500–400	„

This fits in well with the foregoing suggestion. These mesoplanktonic species, though few in actual numbers, of course help to swell the total averages in the table (p. 297) and diagram (fig. K); but if they are taken out, the result is only to put the point of greatest mesoplanktonic intensity of epiplanktonic species a little higher (about 400 fathoms). The whole question seems worthy of attention for future expeditions.

Fig. K.



Distribution in averages of all Ostracods at all depths (comparable hauls).

Explanation of Plate 27.

The upper part of this Plate represents diagrammatically the observed distribution of the different species captured.

* Omitting scarce forms as too few to be significant.

In such a study as the present, where it is difficult to assimilate the meaning of rows of figures of population at various depths, it seems easier to grasp the distribution visually by representing it as a symmetrical plane spindle, rather than by the ordinary curve. This is done by erecting the base-line, by laying off each observation on both sides of the line, and by joining the points thus obtained; in other words, two ordinary curves are set back to back in order to make a symmetrical figure. By this method (which is by no means novel), the maximum intensity—for which I suggest the term plurimum—becomes readily conspicuous.

The observations plotted on the upper part of Plate 27 are:—(1) Average specimens per hour haul for 0, 25, 50, 75, and 100 fm.; the ordinates are set opposite to the depths at which the open nets were towed horizontally. (2) Average specimens per hour haul for greater depths: the ordinates are in this case opposite to the middle of the water-column through which the closing-nets were hauled vertically; thus the average for 400–300 fm. is plotted at 350 fm., the average for 750–500 fm. at 625 fm. This seemed to be the fairest way of representing the facts *. Fractional averages less than 0·5 are represented by a thin line; if more than 0·5 they are taken as 1·0. The hauls with the closing mesoplankton net are separated from those with the open horizontal epiplankton nets by a white space or line. All the figures are plotted to the same scales. The averages per hour haul and per 100 fathom haul are of course not directly comparable with one another, because the mass of water filtered by the vertical closing-net is so much the smaller.

In the lower part of Pl. 27 similar diagrams, to the same horizontal scale, have been used to express roughly my interpretation of the observed facts, and have therefore only the value of a personal opinion. These "distribution spindles" are obtained (1) by omitting those captures which I regard as representing only dead or dying specimens on the grounds already given (pp. 282–3); (2) by a process of "smoothing the curves" by drawing lines from the plurimum to the inferred upper or lower limit, paying regard to intermediate averages in the epiplankton. In these diagrams, unlike the others, it seemed fairest to extend the "distribution spindle" to the extreme possible points, in order to allow for scattered specimens which the net might have possibly missed, owing to the thinning out of a species as we recede from its plurimum in both directions vertically. Thus, if the highest admitted specimens were in a 300–200 fm. haul, the figure has been carried up to 200 fm.; if the lowest admitted specimens occurred between 750–500 fm., it has been carried down to 750 fm.

The same general methods have been adopted for the graphic representation of day and night distribution in fig. L (p. 302), but on a doubled vertical scale.

These diagrams show conclusively how valueless are any generalisations as to the vertical distribution of even a genus of Ostracoda from one place, day, or even hour to another. Still less can such generalisations be made for a family or group. Each species seems to be in a state of chronic movement, and must be studied separately, as an entity with its own specific likes and dislikes; this should be attempted at every separate geographical position possible, if we are ever to understand the laws of planktology.

* The averages for the closing-net 150–50 fm. (21 *p*) are therefore on the 100 fm. ordinates, as well as those for the horizontal open nets at 100 fm. Fortunately, the averages only coincide in the case of *procera*, and will therefore not lead to confusion.

The Vertical Distribution of Individual Species.

In summary of the observations given above, it may be said that the species seem to have been distributed—at the date and in the area investigated—on the following lines:

(*a*) Species confined to the epiplankton . . .	*haddoni, spinirostris, globosa.*
(*b*) Species with a plurimum in the epiplankton, but extending into the upper mesoplankton.	*magna* and A larvæ, *procera, elegans, zetesios.*
(*c*) Species distributed as the last, and with their oldest stage purely mesoplanktonic	*curta, rotundata,* and perhaps *hyalophyllum.*
(*d*) Species extending into the lower epiplankton and with a (probable) plurimum in the upper mesoplankton, extending into the lower mesoplankton	*imbricata, loricata, spinifera, daphnoides.*
(*e*) Purely mesoplanktonic species	*ametra, brachyaskos, pusilla, rhynchena.*

To (*e*) may probably be added *kampta, tyloda, cucullata, pellucida*; to (*b*) *castanea.*

Those species which occurred at any time in the epiplankton may be also classified as:

Those which reached up to 0 fm.	*curta, haddoni, hyalophyllum, magna,* A larvæ, *rotundata, spinirostris, globosa.*
„ „ „ „ 25 „	*daphnoides, elegans.*
„ „ „ „ 50 „	*imbricata, loricata, spinifera, zetesios.*
„ „ „ „ 75 „	*procera.*

It remains to be seen whether, as is possible, this relation is connected with temperature barriers.

It is interesting to note that of Müller's new 'Valdivia' species which were captured by the 'Research,' *ametra, brachyaskos, pusilla, kampta, rhynchena,* and *tyloda* were purely mesoplanktonic species; and that "*stigmatica*" and "*lophura*" were apparently mesoplanktonic oldest stages of known epiplanktonic species. "*Macrocheira*" and "*ctenophora*" seemed to be similarly oldest stages of epiplanktonic species, but were apparently themselves epiplanktonic. It is quite evident that the mesoplankton will be far more productive of new forms than the epiplankton.

Definitive Observations.

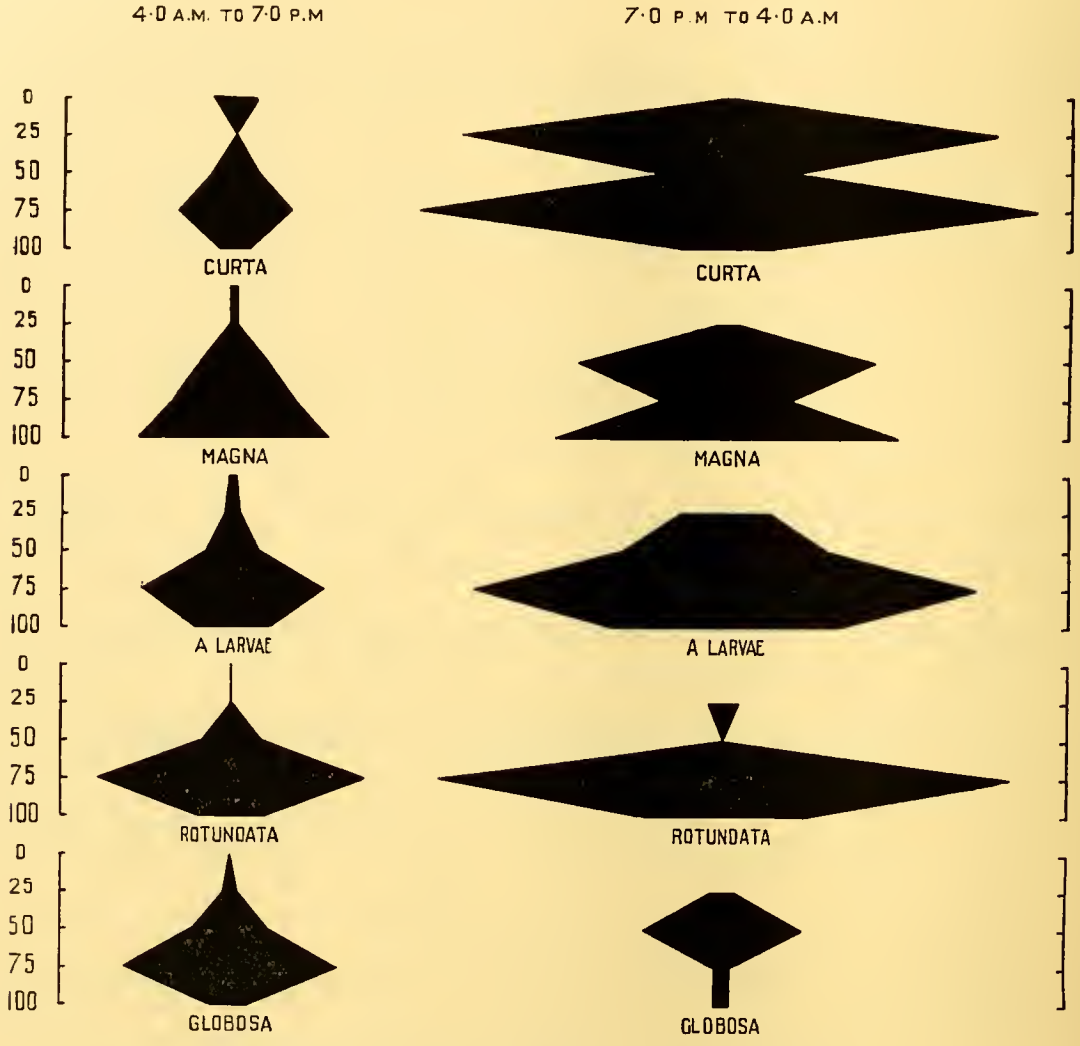
I have employed this term elsewhere to denote those observations which show the outside limits of depth, temperature, &c. between which a species has been captured; they are brought together in the first two main columns of the ensuing table under the heads of "lowest possible" and "highest possible" depths and temperatures. To these I have added—as the expression of a mere personal opinion—my own inferences as to the real lower limits, under the heads of "lowest probable" depths and temperatures. The third and fourth main columns recapitulate, for convenience of reference, the observed plurima, and those general inferences as to distribution and oscillation, in the area and during the period of the cruise, which have been drawn in the text. The temperatures from 25–75 fathoms are unfortunately only approximations (see p. 5); the others from the curve of observations made during the cruise.

	Range in depth ; fathoms.			Range in temperature ; °C.			Plurimum = maximum intensity.			General inferences.				
	Lowest		Highest	Lowest		Highest	Day.		Night.					
	possible.	probable.	possible.	possible.	probable.	possible.	Epipl.	Mesopl.	Epipl.	Pure epipl.	Epipl. & upp. mesopl.	Epipl. to deep mesopl.	Purely mesopl.	Oscillating by night.
ametra	1000	1000	300	4·6	4·6	10·7	sp. abst.	500–400	sp. abst.	..	..	..	+	
brachyaskos	1500	1500	200	3·0	3·0	11·1	sp. abst.	750–500	sp. abst.	..	..	..	+	
curta (young)	1250	250	0	3·6	10·8	17·2	75	(750–500)	27 & 75	..	+	..	..	+
curta (Stage I.)	1250	1250	400	3·6	3·6	10·2	sp. abst.	750–500	sp. abst.	..	..	..	+	
daphnoides	1500	1000	25	3·0	4·6	15·5	sp. practically abst.	400–300	50	..	..	+	..	++
elegans	1000	300	25	4·6	10·7	15·5		?250–150	75	..	+	..	..	++
haddoni	100	100	0	11·5	11·5	17·2	..	sp. abst.	75	+				
hyalophyllum (young)	1250	1250	0	3·6	3·6	17·2	sp. abst.	..	75 & 100	..	..	+	..	+
hyalophyllum (Stage I.)	?1000	?	?	?4·6	..	..	sp. abst.	..	sp. abst.	..	..	..	?+	
imbricata	750	750	50	8·0	8·0	14·4	sp. abst.	400–300	75	..	..	+	..	+
inermis	350	..	+100	10·5	..	+11·5	sp. abst.	..	sp. abst.	..				
kampta	750	750	500	8·0	8·0	9·7	sp. abst.	750–500	sp. abst.	..	..	..	+	
loricata	750	750	50	8·0	8·0	14·4	100	500–400	100	..	..	+		
magna	1500	250	0	3·0	10·8	17·2	100	(750–500)	50 & 100	..	+	..	..	+
"A" larvæ	1500	250	0	3·0	10·8	17·2	75	..	75	..	+	..	..	+
procera	750	250	0	8·0	10·8	17·2	100	..	100	..	+			
pusilla	1000	1000	500	4·6	4·6	9·7	sp. abst.	750–500	sp. abst.	..	..	..	+	
rhynchena	1000	1000	200	4·6	4·6	11·1	sp. abst.	500–400	sp. abst.	..	..	..	+	
rotundata (young)	1000	200	0	4·6	11·1	17·2	75	(750–500)	75	..	+	..	..	+
rotundata (Stage I.)	1500	1500	300	3·0	3·0	10·7	sp. abst.	500–400	sp. abst.	..	..	..	+	
spinifera	1000	..	50	4·6	..	14·4	sp. abst.	?400–300	75 & 100	..	..	+	..	+
spinirostris	100	100	0	11·5	11·5	17·2	75	sp. abst.	?	+				
tyloda	?1500	?1500	1000	?3·0	?3·0	4·6	sp. abst.	..	sp. abst.	..	..	..	+	
zetesios	300	300	50	10·7	10·7	14·4	100	sp. abst.	?	..	+			
globosa	100	100	0	11·5	11·5	17·2	75	sp. abst.	50	+	..	..	..	+
cucullata	1250	1250	300	3·6	3·6	10·7	sp. abst.	..	sp. abst.	..	..	..	+	
castanea	250	..	75	10·8	..	12·7								
pellucida	2000	2000	750	2·6	2·6	8·0	sp. abst.	..	sp. abst.	..	..	..	+	

The Vertical Diurnal Oscillation of the Epiplankton.

It is obvious from the account of the separate species already given that many of them were taken in greater numbers by night than by day. It has been urged upon me more than once in connection with other groups that this is an argument, not for the presence of organisms in greater numbers at night, but for their seeing and avoiding the nets by daylight. Such a criticism can hardly apply to the Halocypridæ, which have no eyes.

Fig. L.



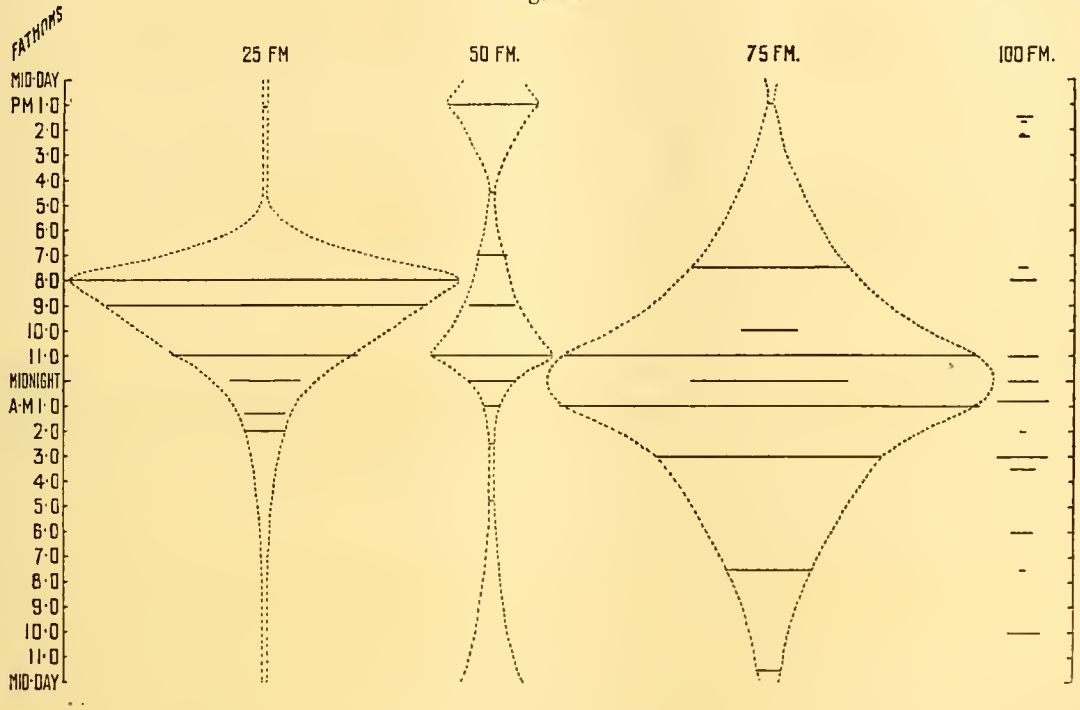
Spindles of day and night distribution of five Halocypridæ.

To what, then, is their capture in greater numbers by night due? I can see no other explanation than that the population is actually increased by a rise of additional specimens from lower levels.

If tow-net hauls could be taken simultaneously at every zone every half-hour for the twenty-four hours, it should be possible to trace the gradual increase and decrease in numbers, and it is with the idea of suggesting such an experiment for the next deep-sea expedition that I venture to print this paragraph. But the work will demand a large and wakeful staff of naturalists.

Supposing that some oceanic species do actually oscillate vertically in the manner attributed to Limnoplankton and Neritic Plankton, there seem to be two possible methods. (1) In the one case, a species may oscillate (as it were) in one piece, plurimum and extremes alike falling and rising simultaneously; in this case the distribution spindle will retain its shape and proportions but will alter its position in depth. As an illustration of what would seem likely to happen in this case, the accompanying diagram (fig. M) of the actual distribution of *curta* during the cruise has been drawn. On the ordinates of the twenty-four hours, the numbers of specimens captured × time-factor have been plotted on both sides of abscissæ representing 25, 50, 75, and 100 fathoms *. The spindles obtained by joining up the ordinates seem to show a plurimum at 25 fathoms at 8.0 P.M., at 50 fathoms at 11 P.M. and again at 1.0 P.M., and at 75 fathoms about midnight. These can be interpreted to mean that the plurimum at 75 fathoms at midnight rises to 50 fathoms by 1 P.M., and to 25 fathoms by 8 P.M., that it sinks again to 50 fathoms by 11 P.M., and back to 75 fathoms at midnight, the fall, aided by gravity, being naturally more rapid than the rise. The slight increase at 100 fathoms towards midnight may be

Fig. M.



due to reinforcement either from above or below, but the numbers were fairly steady at this level all through the twenty-four hours. When similarly treated, there are indications of the same sort of thing in *magna, rotundata,* and the A larvæ, but they are not so clear. The occurrences of the other species were too scattered, and their numbers too few to give any clear result. This oscillation, if true, would account for the puzzling two plurima at different levels, noticeable in the distribution spindles, not only of Ostracods but also of some other species already treated in this series of papers. Thus, for example, the double plurimum of *magna* (fig. L) is apparently produced by a plurimum at 50 fathoms about 9.0 P.M., and another at 100 fathoms about 3.0 A.M.

(2) If only a certain percentage of the specimens of a species rise and fall, the gain and loss will balance at each horizon except the highest and lowest; the plurimum will remain steady, and the spindle will alter its shape and proportions. None of the diagrams made from the 'Research' specimens seem to suggest this.

* The specimens at 0 fm. were too few to be significant.

As to the agency, be it mechanical, chemical, or physical, or a combination of these, which appears to bring certain species up at night, I have only to remark that the distances which have to be traversed in the time seem too great for Ostwald's explanation to be alone adopted for all oceanic species; besides, it is not the whole oceanic plankton that oscillates (as it should by his theory, except in the case of powerful swimmers) but only certain species, if my deductions are correct. Nothing is more puzzling than the sudden appearance during the dark hours (often in very large numbers) of a species which was seldom or never taken in the epiplankton in daylight during the whole cruise. For example, with the exception of a single specimen at 100 fathoms at mid-day, all the 204 epiplanktonic specimens * of *daphnoides* were captured between 8.0 P.M and 3.30 A.M., on fifteen occasions extending over six nights and over an area of (roughly) 45 × 15 minutes. Similarly all the 55 * epiplanktonic specimens of *imbricata* were captured between 8.0 P.M. and 3.30 A.M., on ten occasions extending over four nights in an area of about 35×15 minutes. In such cases the question is not one of a confined swarm, but of similar, if scattered, observations over a fairly large area and period.

The following species showed increased numbers in the epiplankton by night:—*curta* †, *daphnoides*, *elegans*, *hyalophyllum*, *imbricata*, *magna* †, A larvæ †, *rotundata* †, *spinifera*; of these nine, three were never captured at or above 100 fathoms by day, one only once, one only twice. The following showed no such variation in number by day and night:—*haddoni*, *loricata*, *procera*, *spinirostris*, *zetesios*, *globosa* †, but in the last case the plurimum seemed to rise at night.

A point which requires consideration is, how far the plurima observed during the cruise may have been due to some specially favourable conditions on a particular night. On investigation this appears to have been partially the case; this will be seen from the following list, in which are given, for the more plentiful species, those hauls at which the greatest average number per hour were captured:—

	25 *g*	30 *f*	30 *g*	30 *l*	31 *b*	32 *m*	32 *n*	32 *o*	32 *p*	33 *e*	33 *g*	34 *d*	35 *a*	35 *x*	35 *y*
curta	..	..	..	..	..	163	..	166	..	1 55	126	..	..	..	..
daphnoides	..	..	..	79	71	..	..	..	..	..	..	.	..	..	..
elegans	..	..	..	..	..	193	..	123	..	..	..	..	..	..	..
hyalophyllum	..	..	..	..	..	..	..	14	18	..	..	..	..	..	..
magna	101	..	..	89	..	..	..	..	..	..	..	92	..	..	..
A larvæ	111	..	..	..	..	160	..	..	..	..	..	..	..	..	..
procera	..	..	18	..	..	..	..	..	..	..	..	..	..	14	..
rotundata	..	82	..	..	..	275	..	..	..	..	..	..	..	..	72
spinifera	..	..	..	..	..	..	..	13	15	..	..	..	..	..	..

It is obvious that the night on which hauls 32 *m*, *n*, *o*, *p* were made was exceptionally rich: my log records "very fine, smooth, pitch-dark"; but it is doubtful whether the weather had any bearing on the point, as all these four hauls were made at 75 and 100 fathoms. This night, however, was not uniformly the best for all species: *magna* was far more plentiful in 25 *g* and 34 *d*; *daphnoides* again was most plentiful on yet another night.

* Actual numbers. † Compare figure L.

Simultaneous and consecutive Hauls.

It was not realised when the Biscayan cruise was planned how complicated are the movements of the epiplankton. My aim was, to get at least one haul at every hour of the twenty-four at every depth (0, 25, 50, 75, 100 fm.), and more than one at the depths and hours which were believed to be "critical": this plan was almost completely carried out; and in a case where mesoplankton hauls have also to be attended to, where time is limited and workers are few, it is about as much as can be done to fit the epiplankton hauls into the intervals of the mesoplankton work *. But it has become apparent in the course of these investigations that simultaneous hauls at the different horizons would probably in many cases have been more instructive. Of these there were taken comparatively few, but they are significant as showing the "stratification" of species at different depths and hours. A few examples of such hauls are given in the table (p. 306), which illustrate various points.

In the hauls, 30 *m*, 30 *l*, 31 *a*, 31 *b* are examples of simultaneous hauls at 25 and 50 fathoms, taken in two consecutive hours. Both hauls at 50 fm. show nearly the same species, the hauls at 25 fm. show little or nothing else than *curta*. This is a good example of that stratification which ought to be (but is not) universally recognised as a natural corollary of the admitted stratification of physical conditions. Whatever may have been the decisive conditions at 25 fm., it is quite obvious that *curta* liked them and that other species did not.

In the next series, 32 *m*, *n*, *o*, *p*, taken at a time of night and at the horizons where the fauna is thickest, a similar stratification is shown, not in the species, but in the number of specimens of those species at the two levels.

In the third case, 35 *y*, 35 *x*, 36 *a*, 36 *b*, the paired hauls were in the same night, but not in consecutive hours: the interest of these lies in the fact that the first pair were taken between 7.0 and 8.0 P.M. at the beginning of the dark hours and show few or no specimens of those species for which on other grounds a nocturnal rise into the epiplankton has been inferred (*daphnoides*, *elegans*, *hyalophyllum*, *imbricata*, *spinifera*); the second pair, on the other hand, were taken in full night (11.30 P.M. to 12.30 A.M.) and include all these species.

The fourth example, 25 *e*, *g*, shows the difference between two hauls at the same depth at an interval of $2\frac{1}{2}$ hours; the later haul apparently struck a "swarm" of *magna* and A larvæ, which had vanished again from that horizon before 2.0–3.0 A.M. of the same night (25 *k*).

Haul 27 a *and Open Vertical Nets.*

This non-comparable haul from 1250–0 fathoms (a length due to the mesoplankton net having opened but not closed) has been worked out in detail, and illustrates the impossibility of learning anything of the real distribution of plankton by means of

* In a swell, the manœuvring of the ship, in order to keep the wire rope of the mesoplankton net vertical, often made it impracticable to work epiplankton nets simultaneously.

Hour.	Haul and depth.	*curta.*	*daphnoides.*	*elegans.*	*haddoni.*	*hyalophyllum.*	*imbricata.*	*loricata.*	*magna.*	"A" larvæ.	*procera.*	*rotundata.*	*spinifera.*	*spinirostris.*	*zetesios.*	*globosa.*	*curta.*	*daphnoides.*	*elegans.*	*haddoni.*	*hyalophyllum.*	*imbricata.*	*loricata.*	*magna.*	"A" larvæ.	*procera.*	*rotundata.*	*spinifera.*	*spinirostris.*	*zetesios.*	*globosa.*	Haul and depth.	Hour.
10.30 to	30 *m*, 25 fm.	75	..	1	..	..	..	..	..	3	..	..	..	..	..	..	29	..	..	..	..	..	..	..	..	..	..	..	..	..	..	31 *a*, 25 fm.	11.30 P.M. to 12.30 A.M.
11.30 P.M.	30 *l*, 50 fm.	49	79	51	5	..	..	1	89	29	..	..	2	1	..	17	18	71	20	4	..	..	..	27	1	..	..	..	2	..	33	31 *b*, 50 fm.	
10.30 to	32 *m*, 75 fm.	163	8	193	8	3	5	1	44	160	..	275	6	2	..	1	166	4	123	4	14	12	1	12	59	4	63	13	..	..	2	32 *o*, 75 fm.	12.0 to 1.15 or 1.30 P.M.
11.30 P.M.	32 *n*, 100 fm.	13	1	15	1	9	5	..	31	25	3	25	7	..	..	2	20	7	24	4	18	7	5	71	49	5	48	15	..	..	1	32 *p*, 100 fm.	
7.0 to	35 *y*, 75 fm.	63	..	..	..	..	..	1	19	52	3	72	..	..	..	1	63	6	37	..	3	5	..	11	47	..	35	3	..	..	..	36 *a*, 75 fm.	11.30 P.M. to 12.30 A.M.
8.0 P.M.	35 *x* 100 fm.	5	..	6	..	..	..	..	21	26	14	26	..	..	..	1	13	4	13	2	8	9	..	34	45	2	15	3	..	..	1	36 *b*, 100 fm.	
4.0 to 5.0 P.M.	25 *e*, 50 fm.	1	..	..	..	..	..	..	3	2	..	..	..	..	..	..	13	..	..	..	..	..	..	101	111	..	4	..	2	2	60	25 *g*, 50 fm.	6.30 to 7.30 P.M.

Vertical Open Nets, such as have been in fashion on recent expeditions. For the serious study of plankton such hauls are a mere waste of time and energy, however much they may fill museums and multiply species.

From this haul, by itself, nothing could be deduced except that the species included were all present somewhere between 1250 fathoms and the surface, on a particular date, at a particular geographical position. Contemporary observations showed further that the range of possible temperatures was about 3° to 17°·5 C., temperatures which correspond roughly to the mean surface temperatures of Gibraltar and Archangelsk!

These vertical hauls do not even give a means of estimating the proportions in which the various species are present in the area. This is shown by a comparison of the percentage which each species constituted of haul 27 *a* (second column of the table below) with the percentage which these same species formed of the total (actual) numbers captured during the cruise (third column). The fourth column gives the real distribution of the species at the date and time of the cruise as deduced above from a comparison of all the comparable hauls made; it shows—if, indeed, it be necessary to show it—what a mixture of different faunas is brought to the surface by such a method of capture.

	As percentage of haul 27 *a*.	As percentage of all specimens from comparable hauls.	Distribution.
1 *haddoni*	1·44	0·5	Purely epiplankton.
10 *magna*	14·49	16·4	Epiplankton and upper mesoplankton.
6 A larvæ	8·69	18·1	
10 *procera*	14·49	1·6	
1 *elegans*	1·44	8·5	
1 *zetesios*	1·44	0·2	
12 *curta*	17·39	21·9	
8 *rotundata*	11·59	15·8	
3 *hyalophyllum*	4·34	1·3	
3 *loricata*	4·34	0·7	Lower epiplankton to deep mesoplankton.
3 *daphnoides*	4·34	3·3	
3 *ametra*	4·34	0·3	Purely mesoplankton.
3 *rhynchena*	4·34	0·4	
5 broken spec.	7·24		

Missing altogether were, not only the scarce forms *brachyaskos*, *pusilla*, and *spinirostris*, but also the fairly common forms *imbricata*, *spinifera*, and *globosa*.

Except as regards the common species *curta*, *rotundata*, and *magna*, the percentages

in haul 27 *a* would lead to most misleading inferences about the abundance or scarcity of the several species in the district. The mesoplanktonic species in particular are in excess of their real proportions because the net passes through so many more fathoms of mesoplankton than of epiplankton.

It will be noticed that no attempt has been made to compare the foregoing results with the conclusions of other observers. The reason for this is two-fold. It seems a little dangerous to discuss the earlier faunistic records, because it is in many cases doubtful whether two species which Professor Müller has now satisfactorily separated may not have, hitherto, been reported as one. It ought, however, to have been possible to compare the conclusions obtained by a study of the Biscayan material (for the area and period of the cruise) with the records obtained by the 'Valdivia' herself. Unfortunately this is only the case to a very limited extent, owing to the fact that closing-nets were used so little by that expedition, as compared with open vertical nets which in many cases were sunk to considerable depths. Such nets, lowered to (say) 500 fathoms, bring up a mixed sample of two or three different faunas from as many "climates"; they record only the latitude and longitude (which mean nothing to an animal) and a limit of depth (more rarely of temperature), from below which the specimens captured cannot have come. The hauls with the closing-nets would have been more significant if the upper 100 fathoms had been studied systematically at the same time, which was not the case. For the present, therefore, it is better not to make any comparison between the records of the 'Valdivia' and the 'Research.'

V. MISCELLANEOUS NOTES.

Proportion of Males to Females.

If the numbers of the two sexes be expressed as percentages of the total specimens measured, they come out as shown in the table on p. 309.

Leaving out of consideration for a moment the last two species, it would seem that the females formed 56–64 per cent., males 44–36 per cent., of the specimens of the majority of species: the four exceptions to this—*ametra*, *haddoni*, *loricata*, and *rhynchena*—were represented by so few specimens that we cannot be sure that they are really exceptions.

But the last two species are on a different footing. I have already hazarded the suggestion that *zetesios* may possibly prove to be a parthenogenetic form of *magna*, but as only 20 specimens in all were observed, males may have been missed if present only in small numbers. The ratio between males and females of the fairly abundant *globosa*, on the other hand, is startling, and recalls the old history of *Apus*. The 'Valdivia,' like the 'Research,' captured only one male, though the female occurred in 16 hauls and presumably therefore in some numbers. Müller (Naples Monograph, p. 175) regards it as possible that parthenogenesis occurs in some marine Ostracods, but it has not been proved for any Halocyprid; indeed it is difficult to see how it can be "proved" in an oceanic species. Supposing the male captured in haul 22 *b* to be of *globosa*, and not of some other *Halocypris* (at least it seems to be of the same species as Müller's Valdivian

Species.	Specimens.	Female.	Male.
ametra	25	68	32
brachyaskos	16	62	37
curta	200	62	38
daphnoides	200	56	44
elegans	565	57	42
haddoni	42	88	11
hyalophyllum	105	60	40
imbricata	101	64	35
loricata	62	79	20
magna	1171	64	35
procera	147	57	42
rhynchena	39	71	28
rotundata	378	61	38
spinifera	91	64	35
spinirostris	23	56	43
zetesios	20	100	00
globosa	316	99	0·1

male), the fact that it was taken at great depths, while no female was captured below 100 fathoms, points to something very unusual about the domestic arrangements of this species.

The Death-rate.

I had hoped to be able to work this out in several species from the actual numbers captured at successive stages. But there was only one species which fulfilled the necessary conditions for such a study—that it was large, plentiful, and with all its stages represented habitually in the epiplankton *. This species was naturally *magna*, and it is remarkable how its numbers are related. The following are the actual numbers measured and sexed: Stage I., 159; Stage II., 337; Stage III., 675. Now $675 \div 2 = 337$, and $337 \div 2 = 168$. That is to say, the total at each stage when halved yielded approximately the total for the next highest stage; or, in other words, the death-rate was 50 per cent. at Stages II. and III.

The ratio may be a mere coincidence: it takes for granted that reproduction had been going on at a uniform rate for some time—a condition which was obviously not the case in some other species. But the observation seems worth putting on record.

* The latter necessary, owing to the impossibility of direct comparison between the closing-nets and the others.

The Occurrence of closely allied Species in the same Water.

It has been contended that, if the Darwinian canon of the Struggle for Existence be well founded, closely allied species cannot co-exist in the same area ; the one is bound to succumb to the other. The point is worth consideration in such a collection as the present; but the difficulty is to say what constitutes "close" alliance. In one sense, all species of the same genus are closely allied to one another, even though they may be as different morphologically as *curta* and *daphnoides*, and though their mere contour is enough to show that they have responded differently to the stimulus of the Struggle. Such forms are presumably in no more direct competition with each other than with other members of the plankton.

Or, again, we may take as a standard those more subtle differences between the species which Claus expressed as subgenera and Müller as "groups"; these no doubt bring together species of the closest morphological similarity, but take no account of size. Thus, for example, by Müller's grouping, *spinirostris* * with a male mean length of 1·3 mm. is in the same group as *magna* with a male mean length of 2·91 mm. It is not obvious that these two would come into direct competition, but the smaller species will presumably compete with the younger stages of the larger. Such groupings by morphological similarity seem, however, to be the best that we can take as a standard of "close" alliance.

The species captured by the 'Research' are tabulated according to their respective groups on pp. 228–9 ; and in discussing this question I must take it as granted that my deductions † about their vertical distribution—summarised in the lower half of Pl. 27—are approximately correct.

As to the first pair of species—*spinifera* and *inermis*—nothing can be said, since the latter was only observed in a haul which gave no clue to its distribution. The next pair, however,—*procera* and *brachyaskos*—are interesting, since morphologically and in size they are very close to one another; *procera* seems to reach down to about 250 fm. with a plurimum at 100 fm., *brachyaskos* to reach up to about 300 fm. with a plurimum about 450 fm. ; they apparently did not coexist in the same waters. Then come *rotundata* and *pusilla*, morphologically more easily distinguishable than the last pair, but of like size: the younger stages of *rotundata* were probably confined to the upper 200 fathoms, but the oldest stage apparently overlapped *pusilla* to some extent; on the other hand, the plurimum of the former was between 500–400 fm., that of the latter between 750–500 fm.

Next is the *magna*-group, represented by at least three species, *spinirostris* being in many points distinct and probably out of place here. Of these three, *magna* and *zetesios* are of close morphological similarity and both of large size; they certainly seemed to inhabit the same water, and to belong to the epiplankton and upper mesoplankton. On the other hand, *hyalophyllum*, though rising into the epiplankton at night, seemed to

* Müller only places this species provisionally in the *magna*-group ; it seems to me to have more (though uncertain) affinity with the *loricata*-group.

† They were made and Pl. 27 drawn before this paragraph was thought of.

be far more a mesoplanktonic form, and not to come into such direct competition with *magna*, especially as its oldest or "*lophura*' stage was probably purely mesoplanktonic.

Of the three species of the *mollis*-group, two were so scarce that no inference can be drawn. The *imbricata*-group was represented by Stage II. of *imbricata* and *ametra*: these apparently overlapped in the mesoplankton, but the plurimum of *ametra* seemed to be about 500–400 fm., and 300 fm. to be its upper limit, while *imbricata* rose into the epiplankton at night, and its real centre was probably somewhere in the upper 300 fathoms; although overlapping, these two seemed to have different centres of distribution.

In summary—the only closely allied species which seemed to come into direct competition were *magna* and *zetesios*.

VI. GENERAL LIST OF SPECIES AND SPECIMENS BY HAULS AND DEPTHS.

With the exception of the first two (27 *a*, 36 *l*) the list has been confined to comparable hauls. The number of specimens between 0 and 100 fathoms has been multiplied by a time-factor, where necessary, to bring all to the standard one-hour haul; the numbers below 100 fathoms are actual numbers. The columns headed "Totals" include broken specimens, indeterminable larvæ, and eight species which occurred but seldom; the captures of these eight will be found recorded in the text.

Depth in fathoms.	Haul.	*ametra.*	*brachycaskos.*	*curta.*	*daphnoides.*	*elegans.*	*haddoni.*	*hyalophyllum.*	*imbricata.*	*loricata.*	*magna.*	"A" larvæ.	*procera.*	*pusilla.*	*rhynchena.*	*rotundata.*	*spinifera.*	*spinirostris.*	*zetesios.*	*globosa.*	Totals.
1250—0	27 *a*	3	..	12	3	1	1	3	..	3	10	6	10	..	3	8	..	..	1	..	69
350—0	36 *l*	3	..	9	8	8	1	6	10	5	15	15	6	..	7	4	4	..	..	..	..
0	21 *e*																				
	22 *d*	..	..	4	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	12
	23 *b*	..	..	35	..	..	..	..	..	..	6	5	..	..	..	1	..	..	..	5	55
	23 *d*	..	..	11	..	..	..	..	..	..	2	2	2	..	..	1	..	..	..	2	26
	23 *e*	..	..	2	..	..	..	..	..	..	1	3	..	..	..	..	..	..	..	..	8
	24 *f*	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
	24 *g*																				
	24 *i*	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	3
	25 *b*	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
	25 *h*																				
	25 *i*																				
	25 *l*																				
	30 *c*																				
25—0	26 *a*	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	2	4
	30 *b*	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	2	3
	30 *m*	..	..	75	..	1	..	..	..	..	..	3	..	..	..	..	..	..	..	..	79
	31 *a*	..	..	29	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	29
	32 *b*	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
	32 *e*	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1	2
	33 *e*	..	..	155	..	..	1	..	..	..	13	55	..	..	..	16	..	..	..	6	247
	33 *g*	..	..	126	..	3	..	1	..	..	2	12	..	..	..	3	..	..	..	7	156
	34 *a*	..	..	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	18
	34 *g*	..	..	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	2
	35 *w*	..	..	..	..	..	..	..	..	..	5	10	..	..	..	1	..	1	..	7	26
	36 *c*	..	..	17	2	5	3	..	..	..	..	2	..	..	..	3	..	..	..	..	33
50—0	21 *g*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	2
	25 *e*	..	..	1	..	..	..	..	..	..	3	2	..	..	..	..	..	..	..	..	6
	25 *g*	..	..	13	..	..	..	..	..	..	101	111	..	..	..	4	..	2	2	60	296
	25 *k*	..	..	3	..	3	..	..	..	..	5	2	..	..	..	..	..	..	..	9	22
	26 *c*	..	..	..	..	..	..	..	..	..	8	4	..	..	..	..	..	..	2	6	20
	30 *d*	..	..	..	..	..	..	..	..	1	31	24	..	..	..	3	..	1	..	27	88
	30 *l*	..	..	49	79	51	5	..	..	1	89	29	..	..	..	..	2	1	..	17	329
	31 *b*	..	..	18	71	20	4	..	..	..	27	1	..	..	..	..	..	2	..	33	181
	32 *a*	..	..	2	..	..	..	..	..	..	11	6	..	..	..	1	..	1	..	23	44
	32 *h*	..	..	36	..	1	..	..	..	1	4	15	..	..	..	51	..	..	..	2	110
	33 *c*	..	..	..	..	..	..	..	..	..	3	1	..	..	..	..	..	..	..	10	14
	33 *f*	..	..	19	..	4	..	..	..	..	4	4	..	..	..	2	..	..	..	5	38
	36 *d*	..	..	7	4	9	..	2	1	..	5	15	..	..	..	..	4	..	..	..	49
75—0	30 *f*	..	..	10	..	..	..	..	..	..	36	31	..	..	..	82	..	2	1	38	203
	32 *g*	..	..	1	..	..	..	..	..	1	8	17	1	..	..	23	..	2	1	3	59
	32 *m*	..	..	163	8	193	8	3	5	1	44	160	..	..	..	275	6	2	..	1	890
	32 *o*	..	..	166	4	123	4	14	12	1	12	59	4	..	..	63	13	..	..	2	487
	33 *h*	..	..	23	3	1	1	1	..	1	18	16	..	..	..	4	..	..	..	1	70
	34 *c*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	6	8
	35 *a*	..	..	89	1	9	2	..	..	..	17	126	2	..	..	68	..	..	..	1	318
	35 *e*	..	..	35	..	1	1	..	..	1	5	23	1	..	..	44	..	..	..	44	155
	35 *y*	..	..	63	..	..	..	..	..	1	19	52	3	..	..	72	..	..	..	1	215
	36 *a*	..	..	63	6	37	..	3	5	..	11	47	..	..	..	35	3	..	..	..	215

Depth in fathoms.	Haul.	*ametra.*	*brachyaskos.*	*curta.*	*daphnoides.*	*elegans.*	*haddoni.*	*hyalophyllum.*	*imbricata.*	*loricata.*	*magna.*	"A" larvæ.	*procera.*	*pusilla.*	*rhynchena.*	*rotundata.*	*spinifera.*	*spinirostris.*	*zetesios.*	*globosa.*	Totals.
100—0	21 *h*	..	..	..	..	..	..	..	..	..	12	..	..	..	..	6	..	2	..	14	36
	21 *l*	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	2
	22 *a*	..	..	..	..	..	..	..	..	..	10	1	2	..	..	2	..	..	..	2	18
	24 *b*	..	..	14	..	..	..	..	..	7	51	1	7	..	..	9	..	..	3	5	97
	24 *e*	..	..	1	..	..	..	..	..	7	17	5	7	..	..	..	..	..	..	6	44
	25 *d*	..	..	4	..	..	..	..	..	3	26	7	..	..	..	12	..	1	7	11	71
	30 *g*	..	..	7	..	..	..	..	..	..	36	11	18	..	..	8	..	2	..	4	91
	32 *d*	..	..	8	..	1	..	..	..	2	61	56	9	..	..	28	..	2	..	2	169
	32 *n*	..	..	13	1	15	1	9	5	..	31	25	3	..	..	25	7	..	..	2	137
	32 *p*	..	..	20	7	24	4	18	7	5	71	49	5	..	..	48	15	..	..	1	283
	33 *d*	..	..	11	..	3	1	..	1	1	13	11	..	..	..	6	..	..	1	..	48
	34 *b*	..	..	5	1	6	1	3	1	1	57	38	2	..	..	28	7	..	..	6	156
	34 *d*	..	..	10	4	3	..	..	3	1	92	19	..	..	..	3	2	1	..	3	141
	35 *b*	..	..	21	1	8	3	1	..	..	37	30	4	..	..	15	..	..	..	2	123
	35 *f*	..	..	3	..	..	..	..	..	..	9	11	2	..	..	13	..	..	..	2	42
	35 *x*	..	..	5	..	6	..	..	..	..	21	26	14	..	..	26	..	..	..	1	102
	36 *b*	..	..	13	4	13	2	8	9	..	34	45	2	..	..	15	3	..	..	1	150
150—50	21 *p*	..	..	7	..	..	..	..	..	1	6	5	4	..	..	6	..	..	..	..	30
150—100	21 *n*	..	..	..	..	..	..	..	..	..	9	4	..	..	..	..	..	..	..	..	14
200—100	21 *b*	..	..	..	..	..	..	..	..	..	1	2	1	..	..	..	..	..	..	..	4
	21 *o*	..	..	..	..	..	..	..	..	..	6	4	2	..	..	..	..	..	..	..	13
	26 *e*	..	..	..	..	1	..	..	..	..	2	..	1	..	..	..	..	..	..	..	4
	34 *h*	..	..	3	..	1	..	4	..	..	1	8	2	..	..	9	..	..	..	..	28
	35 *m*	..	..	11	..	..	..	..	..	1	4	8	3	..	..	14	..	..	1	..	43
	35 *n*	..	..	13	..	1	..	..	..	..	5	15	5	..	..	10	..	..	..	..	52
	35 *t*	..	..	..	..	3	..	..	..	..	1	3	..	..	..	1	1	..	..	..	9
250—150	35 *o*	..	..	5	..	2	..	..	..	..	1	3	..	..	..	1	1	..	..	..	13
	35 *p*	..	..	2	..	1	..	..	..	..	1	..	1	..	..	1	1	..	..	..	7
	35 *s*	..	..	1	..	4	..	1	..	..	1	2	..	..	..	..	1	..	..	..	10
300—200	21 *c*	..	1	2	1	3	..	2	3	1	1	2	1	..	1	2	1	..	1	..	27
	26 *f*	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	5
	35 *l*	..	..	..	1	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	2
400—300	21 *k*	2	..	..	6	1	..	..	3	2	..	..	..	..	..	2	4	..	..	..	23
	32 *l*	..	..	1	1	..	..	..	1	..	1	3	..	..	3	..	1	..	..	..	12
	35 *k*	..	..	..	..	..	..	..	1	..	1	..	..	..	1	1	..	..	..	..	5
500—400	21 *m*	8	..	5	4	1	..	2	1	4	1	1	..	..	6	4	1	..	..	..	41
	35 *h*	2	1	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	7
	35 *i*	1	..	1	2	..	..	..	2	..	1	..	..	..	2	..	..	..	..	..	13
750—500	22 *b*	2	1	7	2	..	..	3	..	..	5	..	..	1	1	2	1	..	..	♂	33
	30 *k*	..	2	..	..	2	..	1	..	..	1	..	..	..	..	3	..	..	..	.	12
	34 *e*	2	3	14	4	..	..	..	..	..	3	..	..	2	..	2	2	..	..	..	38
	34 *f*	4	5	12	2	1	..	2	4	1	2	2	1	2	11	3	1	..	..	..	56
1000—750	23 *a*	..	..	4	4	1	..	2	..	..	1	1	..	..	3	..	..	..	..	..	20
	27 *c*																				
	31 *d*	1	..	1	..	..	..	..	..	..	2	..	..	..	..	2	..	..	..	..	8
	32 *f*	..	1	1	..	..	..	1	..	..	..	..	..	..	..	3	..	..	..	..	6
	32 *k*	..	2	1	1	..	..	1	..	..	2	1	..	1	..	2	1	..	..	..	13
1250—1000	24 *a*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	27 *b*	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	31 *c*	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	4
1500—1250	25 *f*																				
	30 *i*	..	2	..	1	..	..	..	..	..	..	1	..	..	..	2	..	..	..	..	7
2000—1500	25 *c*																				
	26 *b*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1

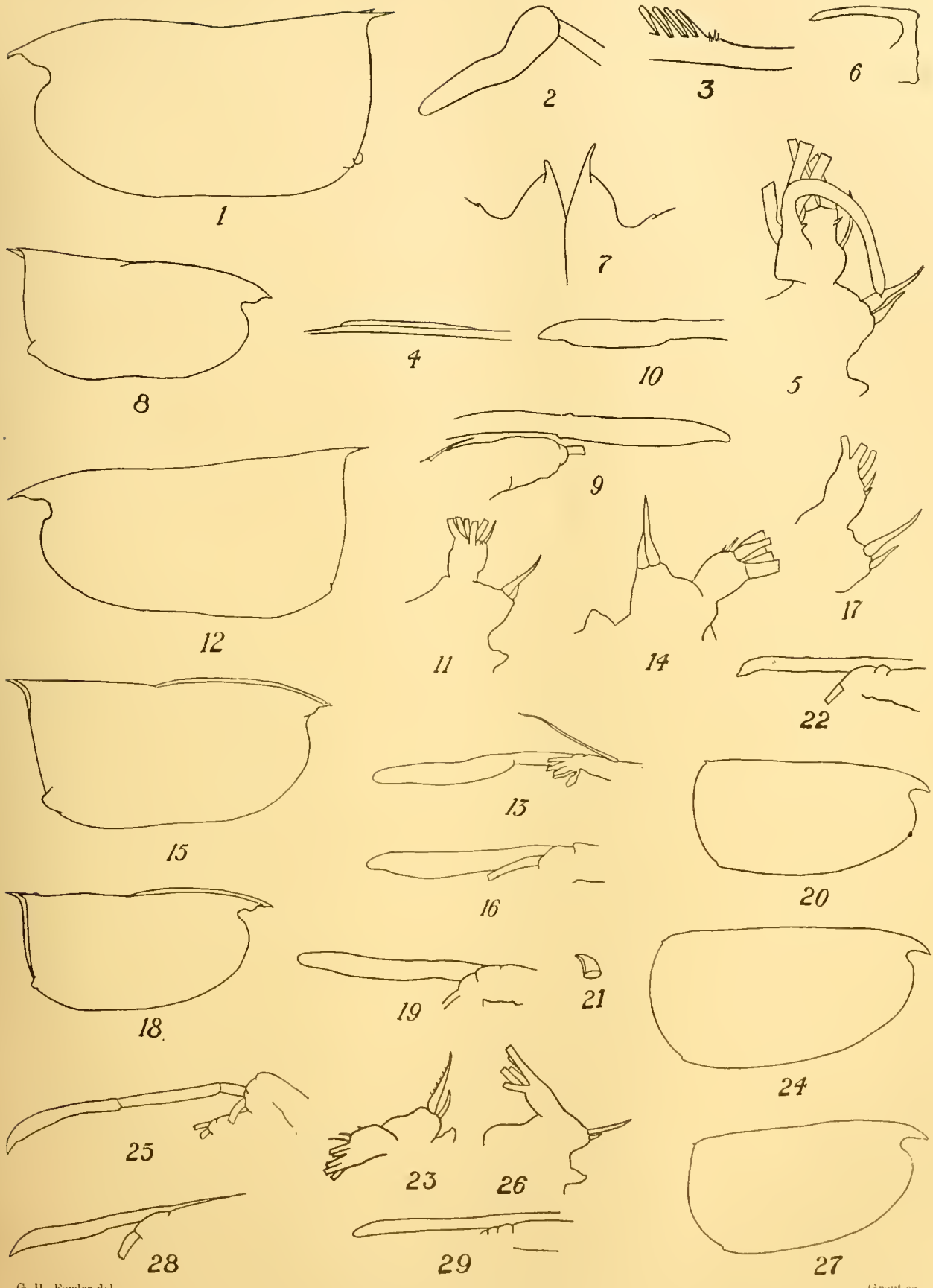
Plate 16.

Conchœcia ametra, Müller.

Male.	Stage II.	Fig.	1. Shell, 3·0 mm.
			2. Frontal organ, 3·0 mm.
			3. Distal end of armature of principal bristle of antenna i., 3·1 mm.
			4. Pad on proximal accessory bristle of antenna i., 3·2 mm.
			5. Hook-joint and neighbouring structures of inner limb of right antenna ii., 3·1 mm.
			6. Hook-joint of left antenna ii., 3·1 mm.
			7. The rostra viewed from inside, 3·0 mm.
	Stage III.		8. Shell, 2·3 mm.
			9. Frontal organ, and end of antenna i., 2·2 mm.
	Stage IV.		10. Frontal organ, 1·6 mm.
			11. Inner joint of antenna ii., 1·6 mm.
Female.	Stage II.		12. Shell, 3·5 mm.
			13. Frontal organ, and end of antenna i., 3·5 mm.
			14. Inner joint of antenna ii., 3·5 mm.
	Stage III.		15. Shell, 2·3 mm.
			16. Frontal organ, and end of antenna i. (the dorsal bristle not shown), 2·3 mm.
			17. Inner joint of antenna ii., 2·3 mm.
	Stage IV.		18. Shell, 1·5 mm.
			19. Frontal organ, and end of antenna i., 1·5 mm.

Conchœcia brachyaskos, Müller.

Male.	Older stage.	Fig.	20. Shell, 1·2 mm.
			21. Tooth of armature of antenna i.
	Younger stage.		22. Frontal organ, 0·9 mm.
			23. Inner branch of antenna i., 0·9 mm.
Female.	Older stage.		24. Shell, 1·4 mm.
			25. Frontal organ, 1·4 mm.; antenna i. accidentally displaced.
			26. Inner branch of antenna ii., 1·2 mm.
	Younger stage.		27. Shell, 0·8 mm.
			28. Frontal organ, 0·9 mm.
			29. Frontal organ, 0·8 mm.



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BISCAYAN OSTRACODA.

Plate 17.

Conchœcia curta, Lubbock.

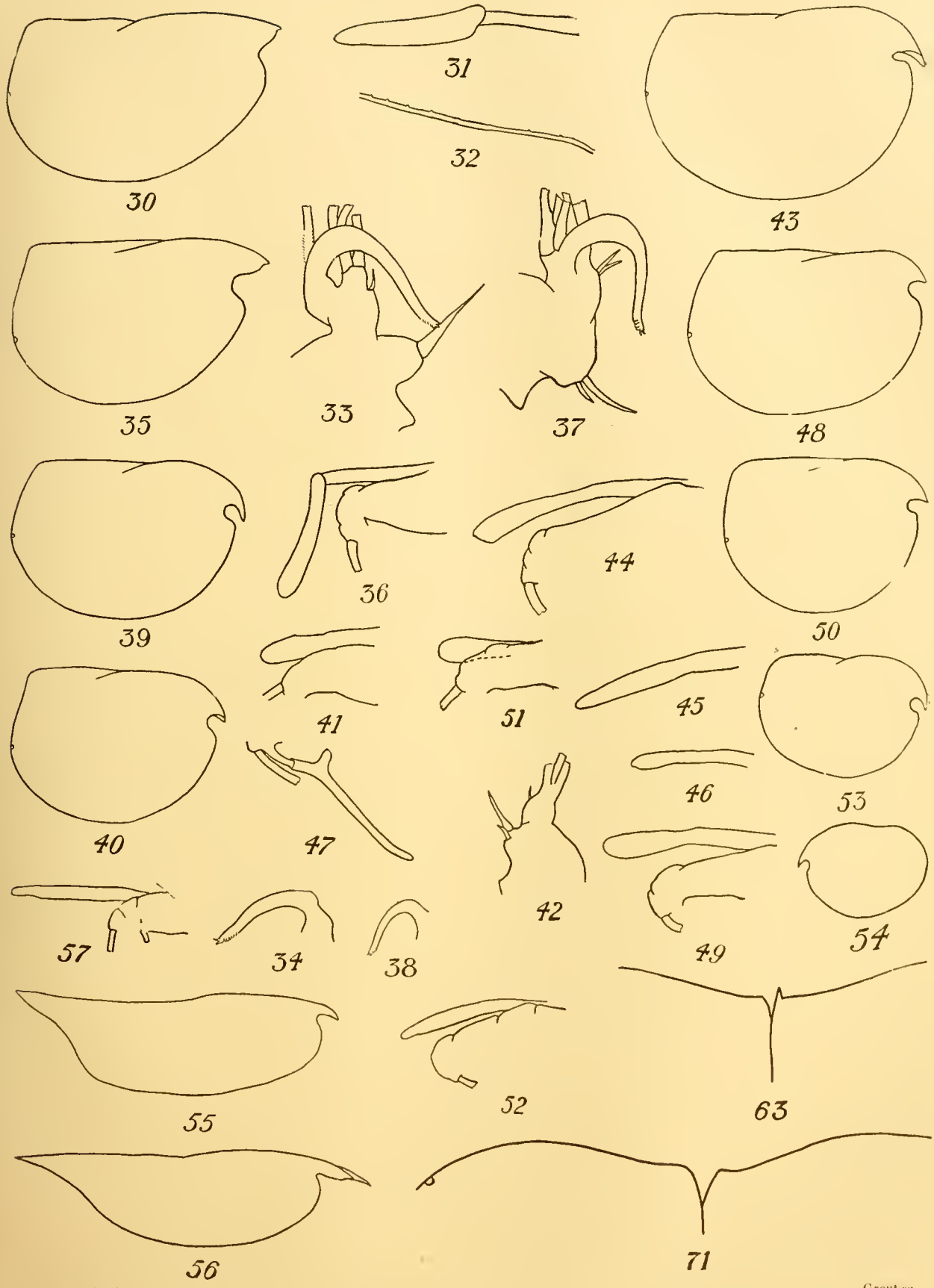
Male.	Stage I.	Fig. 30. Shell, 1·02 mm. (*stigmatica* stage).
		31. Frontal organ, 1·0 mm.
		32. Armature of principal bristle of antenna i., 1·0 mm.
		33. Inner joint of right antenna ii. (one basal and one central bristle are obscured by their fellows), 1·0 mm.
		34. Hook of left antenna ii., 1·0 mm.
	Stage II.	35. Shell, 0·82 mm. (*curta* stage).
		36. Frontal organ, and part of antenna i., 0·75 mm.
		37. Inner joint of right antenna ii., 0·8 mm.
		38. Hook of left antenna ii., 0·8 mm.
	Earlier stages.	39. Shell, 0·82 mm. (before acquirement of secondary sexual characters).
		40. Shell, 0·59 mm.
		41. Frontal organ, and part of antenna i., 0·59 mm.
		42. Inner branch of antenna ii., 0·59 mm.
Female.	Stage I.	43. Shell, 1·01 mm. (*stigmatica* stage).
		44. Frontal organ, and part of antenna i., 1·01 mm.
		45. Frontal organ, 1·01 mm.
		46. Frontal organ, 1·01 mm.
		47. Distal sense-tube of antenna ii., 1·01 mm.
	Stage II.	48. Shell, 0·80 mm. (*curta* stage).
		49. Frontal organ, and part of antenna i., 0·8 mm.
	Earlier stages.	50. Shell, 0·59 mm.
		51. Frontal organ, and part of antenna i., 0·59 mm.
		52. Frontal organ, and part of antenna i., 0·57 mm.
		53. Shell, 0·45 mm.
		54. Shell, 0·39 mm.

Conchœcia daphnoides, Claus.

Male.	Stage I.	Fig. 55. Shell, 2·3 mm.
Female.	Stage III.	56. Shell, 1·2 mm.
		57. Frontal organ, and part of antenna i., 1·2 mm.

Conchœcia elegans, Sars.

Male.	Stage. II.	Fig. 63. Postero-dorsal angles of the shell from inside.
Female.	Stage III.	71. The same.



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BISCAYAN OSTRACODA.

Plate 18.

Conchœcia elegans, Sars.

Male.	Stage II.	Fig. 58. Shell, 1·1 mm.
		59. Frontal organ, 1·1 mm.
	Stage III.	60. Shell, 0·9 mm.
		61. Frontal organ, and antenna i., 0·9 mm.
		62. Frontal organ, 0·9 mm.
	Stage IV.	64. Shell, 0·6 mm.
Female.	Stage II.	65. Shell, 1·1 mm.
		66. Inner branch of antenna ii., 1·1 mm.
	Stage III.	67. Shell, 0·9 mm.
		68. Frontal organ, and end of antenna i., 0·8 mm.
		69. Frontal organ, 0·8 mm.
	Stage IV.	70. Shell, 0·6 mm.
	Stage V.	72. Shell, 0·4 mm.

Conchœcia haddoni, Brady and Norman.

Male.	Stage I.	Fig. 73. Shell, 2·1 mm.
	Stage III.	75. Shell, 1·0 mm.

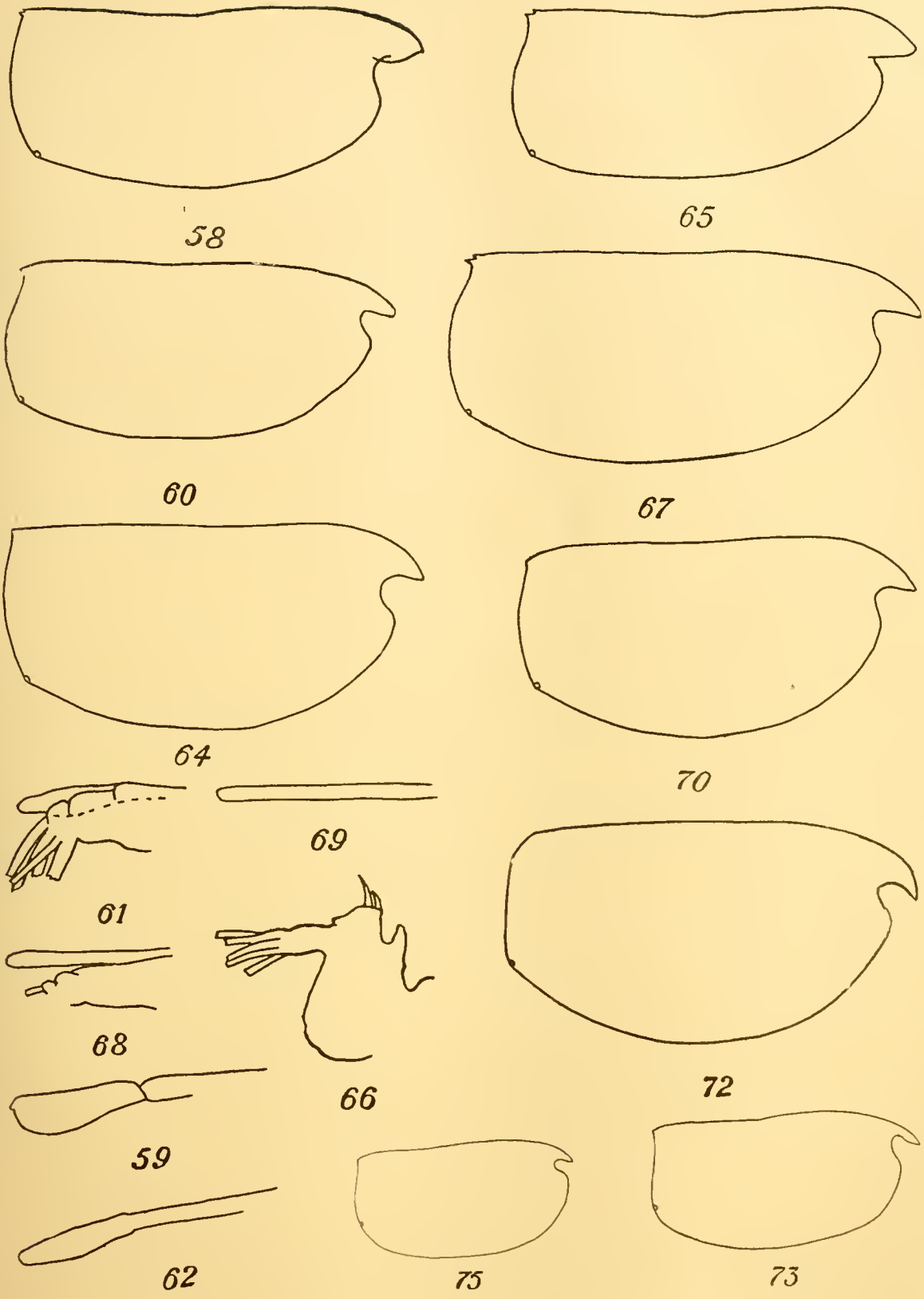

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Plate 19.

Conchœcia haddoni, Brady and Norman.

Male.	Stage I.	Fig. 74. Inner branch of antenna ii., 2·1 mm.
	Stage III.	76. Frontal organ, and part of antenna i., 1·0 mm.
		77. Inner branch of antenna ii., 1·0 mm.
Female.	Stage I.	78. Shell, 2·8 mm.
	Stage II.	79. Shell, 1·6 mm.
		80. Frontal organ, and part of antenna i., 1·6 mm.
		81. Inner branch of antenna ii., 1·6 mm.
	Stage III.	82. Shell, 1·0 mm.
		83. Frontal organ, and part of antenna i., 1·0 mm.
		84. Inner branch of antenna ii., 1·0 mm.
	Stage IV.	85. Shell, 0·7 mm.
		86. Frontal organ, and part of antenna i., 0·7 mm.
		87. Inner branch of antenna ii., 0·7 mm.
	Stage V.	88. Shell, 0·4 mm.
		89. Frontal organ, 0·4 mm.

Conchœcia hyalophyllum, Claus.

Male.	Stage I.	Fig. 90. Shell, 2·3 mm. (*lophura* stage).
		91. Frontal organ, 2·3 mm.
		92. Inner branch of right antenna i., 2·3 mm.
	Stage II.	93. Shell, 1·5 mm. (*hyalophyllum* stage).
		94. Frontal organ, 1·5 mm.
		95. Inner branch of right antenna i., 1·5 mm.
		96. Hook and surrounding structures of left antenna i.
	Stage III.	98. Shell, 1·1 mm.
	Stage IV.	100. Shell, 0·7 mm.
		101. Frontal organ, 0·7 mm.
Female.	Stage I.	102. Shell, 2·5 mm. (*lophura* stage).
	Stage II.	105. Shell, 1·7 mm. (*hyalophyllum* stage).
	Stage III.	108. Shell, 1·0 mm.

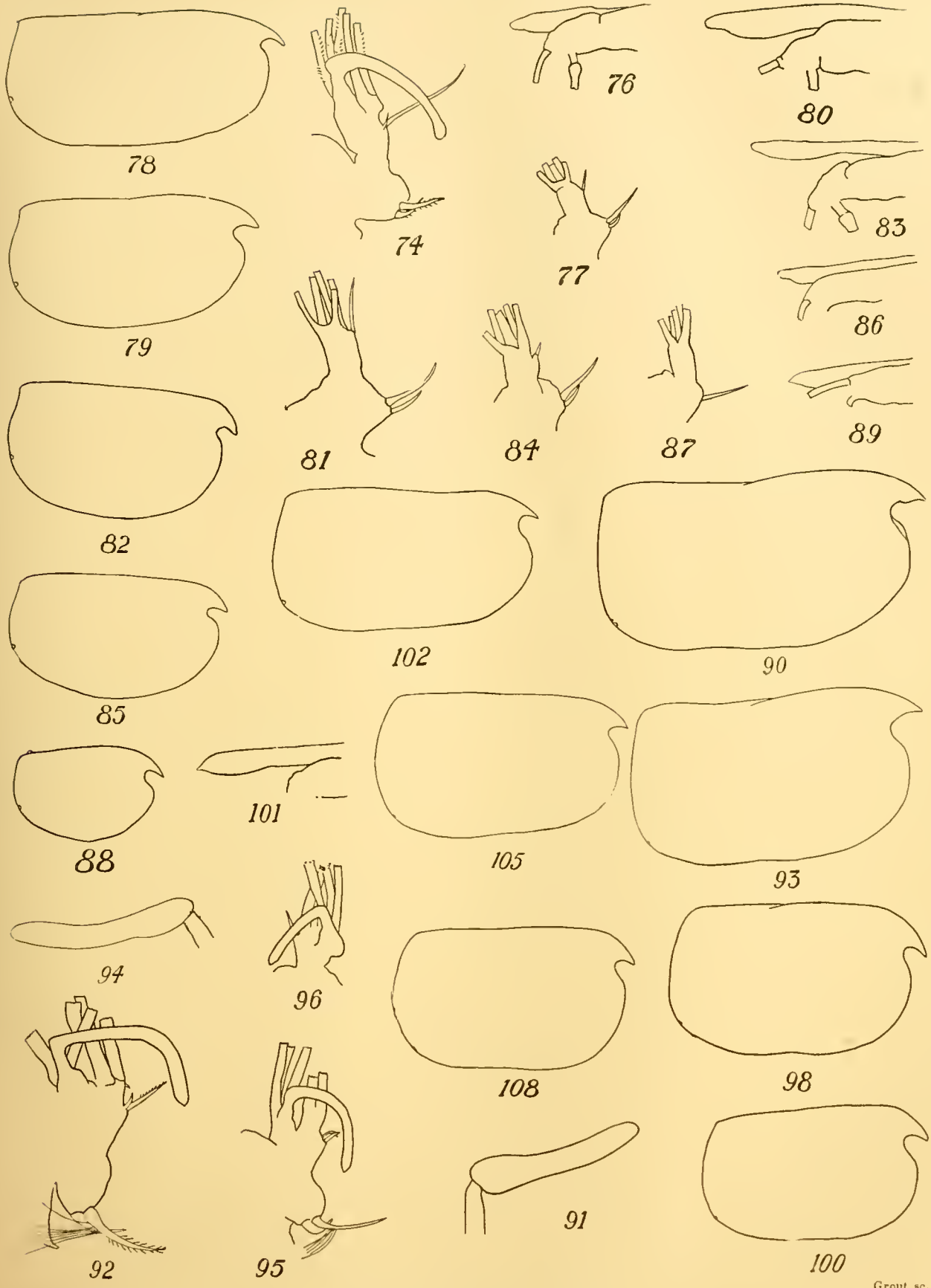

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Plate 20.

Conchœcia hyalophyllum, Claus.

Male.	Stage II.	Fig. 97. Opening of left lateral gland, from inside, 1·5 mm.
	Stage III.	99. Frontal organ, and end of antenna i., 1·1 mm.
Female.	Stage I.	103. Frontal organ, and part of antenna i., 2·5 mm.
		104. Part of inner branch of antenna ii., 2·5 mm.
	Stage II.	106. Frontal organ, 1·7 mm.
		107. Central bristles of inner branch of antenna ii., 1·7 mm.
	Stage III.	109. Frontal organ, and end of antenna i., 1·0 mm.

Conchœcia imbricata (Brady pars), Müller.

Male.	Stage II.	Fig. 110. Hook and bristles of antenna ii., right side, 2·0 mm.
		111. Hook of left side, 2·0 mm.
	Stage III.	112. Shell, 1·5 mm.
	Stage IV.	113. Shell, 1·0 mm.
		114. Frontal organ, and end of antenna i., 1·0 mm.
Female.	Stage II.	115. Frontal organ, and end of antenna i., 2·5 mm.
		116. Part of antenna ii., 2·5 mm.
	Stage III.	117. Shell, 1·5 mm.
		118. Frontal organ, and end of antenna i., 1·5 mm.
	Stage IV.	119. Shell, 1·0 mm.
		120. Frontal organ, 1·0 mm.
	Stage V.	121. Shell, 0·6 mm.

Conchœcia inermis, Claus.

Male.	Stage ?II.	Fig. 122. Shell, 1·9 mm.
	Stage ?III.	123. Shell, 1·5 mm.
		124. Frontal organ, and part of antenna i., 1·5 mm.
		125. The rostra, from inside, 1·5 mm.
Female.	Stage ?II.	126. Right shell, from inside, 2·0 mm.

Conchœcia loricata, Claus.

Male.	Stage I.	Fig. 128. Frontal organ, 2·4 mm.
		129. Armature of antenna i., 2·4 mm.
	Stage III.	132. Frontal organ, 1·4 mm.
		133. Inner branch of antenna ii., 1·4 mm.
Female.	Stage I.	135. Inner branch of antenna i., 2·6 mm.
	Stage III.	138. Frontal organ, and end of antenna i., 1·2 mm.

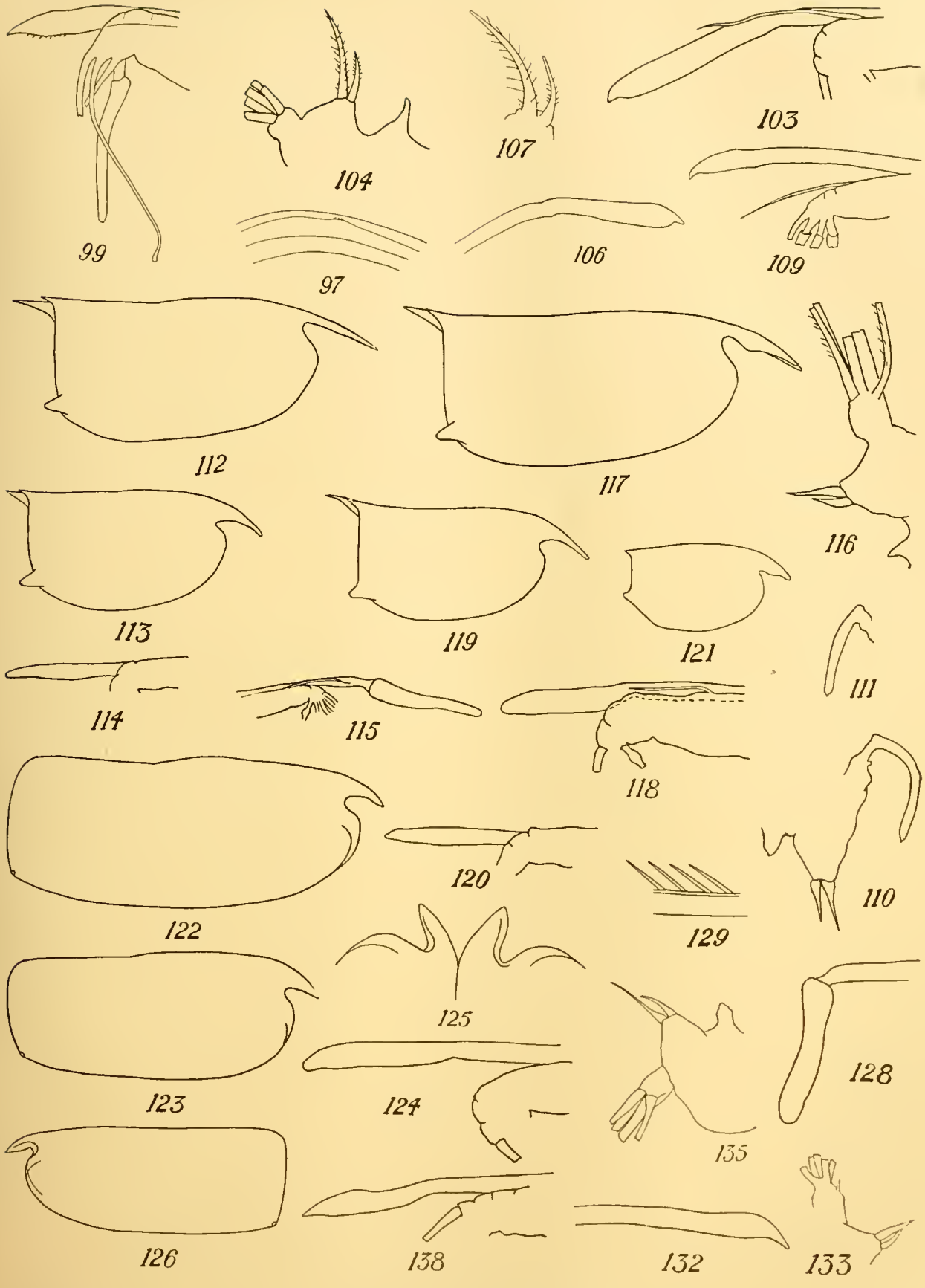

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Plate 21.

Conchœcia loricata, Claus.

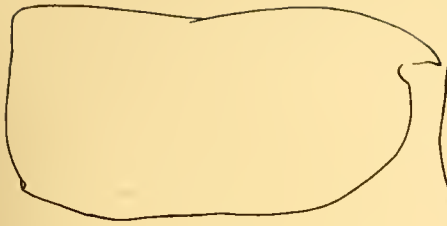
Male.	Stage I.	Fig. 127. Shell, 2·4 mm. (*ctenophora* stage).
	Stage II.	130. Shell, 1·8 mm. (*loricata* stage).
	Stage III.	131. Shell, 1·4 mm. (antero-dorsal region slightly distorted, owing to repeated opening).
Female.	Stage I.	134. Shell, 2·6 mm. (*ctenophora* stage).
	Stage II.	136. Shell, 2·0 mm. (*loricata* stage).
	Stage III.	137. Shell, 1·2 mm.

Conchœcia magna, Claus.

Male.	Stage I.	Fig. 139. Shell, 3·0 mm. (*macrocheira* stage).
		140. Frontal organ, 2·8 mm.
		141. Armature from about the middle of the toothed part of the principal bristle of antenna i., 2·9 mm.
		142. Hook of antenna ii., right side, 2·8 mm.
		143. Central bristles of the inner branch of antenna ii.; the hairs were very long, but are much foreshortened, 2·8 mm.
	Stage II.	144. Shell, 1·8 mm. (*magna* stage).
	Stage III.	149. Shell, 1·3 mm.
Female.	Stage I.	151. Shell, 3·3 mm. (*macrocheira* stage).
	Stage II.	154. Shell, 1·9 mm. (*magna* stage).
	Stage III.	158. Shell, 1·2 mm.

The A Larvæ.

Male.	Stage IV.	Fig. 161. Shell, 0·9 mm.
Female.		164. Shell, 0·9 mm.
Male.	Stage V.	166. Shell, 0·5 mm.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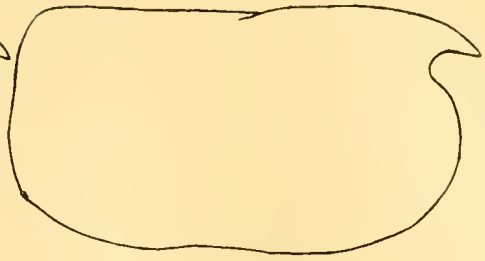
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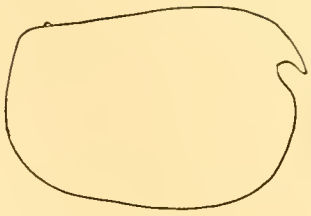
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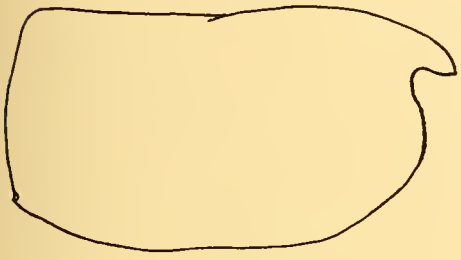
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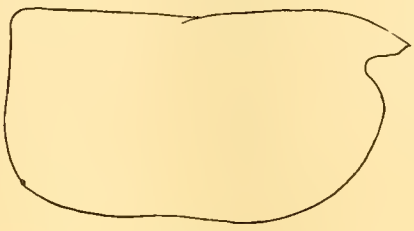
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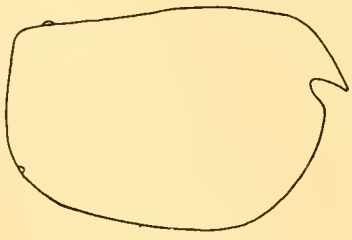
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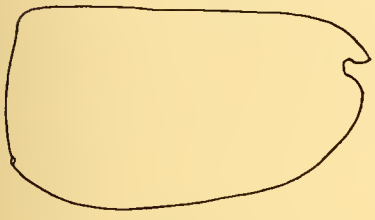
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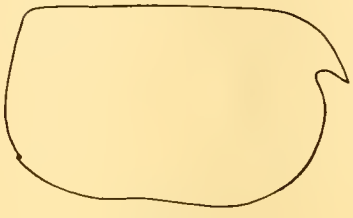
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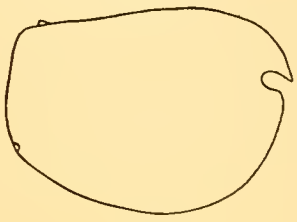
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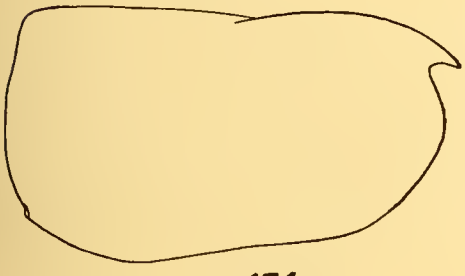
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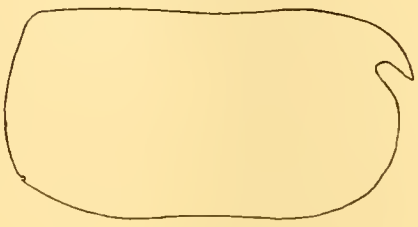
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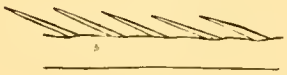
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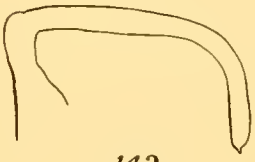
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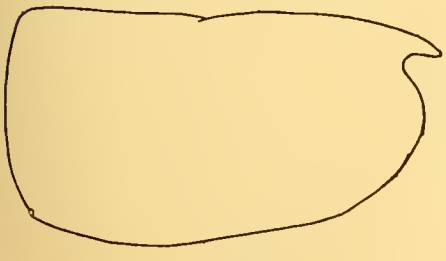
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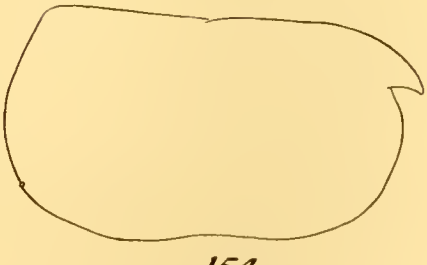
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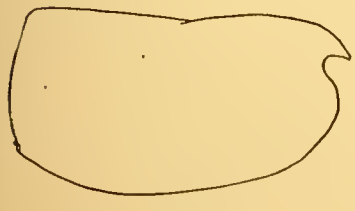
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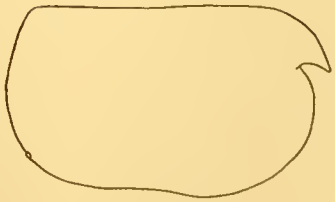
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Plate 22.

Conchœcia magna, Claus.

Male.	Stage II.	Fig. 145. Frontal organ, 1·8 mm.
		146. Armature from about the middle of the toothed part of the principal bristle of antenna i., 1·8 mm.
		147. Hook of antenna ii., right side, 1·8 mm.
		148. Central bristles of the inner branch of antenna ii., the hairs foreshortened on one side.
	Stage III.	150. Frontal organ, usual form, with sharp terminal spike, 1·3 mm.
Female.	Stage I.	152. Part of dorsal bristle of antenna i., 3·4 mm.
		153. Central bristles of inner branch of antenna ii., 3·4 mm.
	Stage II.	155. Frontal organ and end of antenna i., the bristles and tubes cut short. The dorsal bristle accidentally omitted, 1·9 mm.
		156. Part of the dorsal bristle of antenna i., 2·1 mm.
		157. Central bristles of the inner branch of antenna ii. The shorter does not always show hairs, 2·1 mm.
	Stage III.	159. Frontal organ of usual form, and antenna i. carrying a hairless, very fine dorsal bristle, 1·2 mm.
		160. Central bristles of inner branch of antenna ii., 1·2 mm.

The A Larvæ.

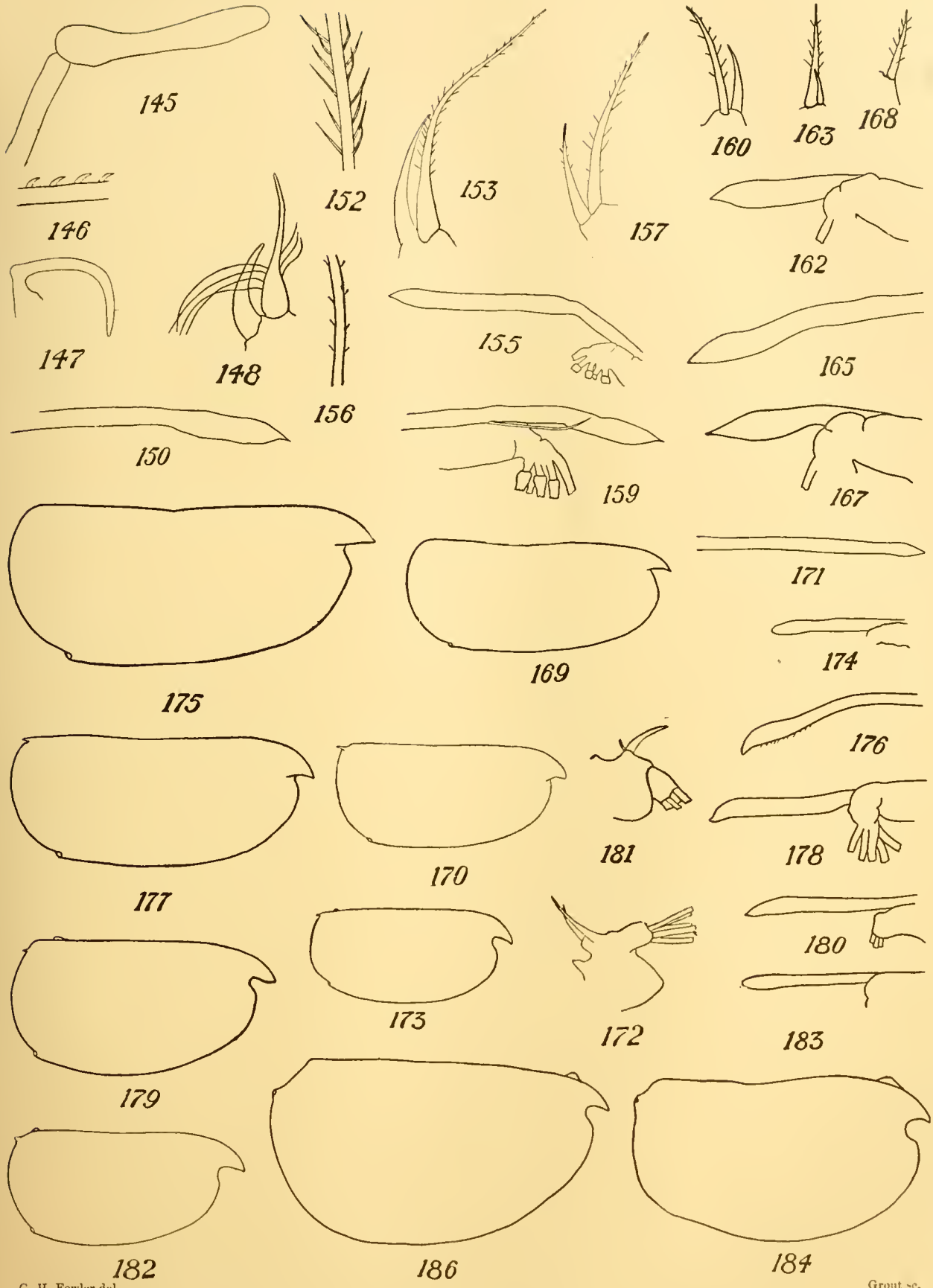
Male.	Stage IV.	Fig. 162. Frontal organ, and part of antenna i., 0·9 mm.
		163. Central bristles of antenna ii., 0·9 mm.
Female.	Stage IV.	165. Frontal organ, 0·8 mm.
Male.	Stage V.	167. Frontal organ, and part of antenna i., 0·5 mm.
		168. Central bristle of antenna ii., 0·5 mm.

Conchœcia procera, Müller.

Male.	Stage II.	Fig. 169. Shell, 1·1 mm.
	Stage III.	170. Shell, 0·9 mm.
		171. Frontal organ, 0·9 mm.
		172. Inner branch of antenna ii., 0·9 mm.
	Stage IV.	173. Shell, 0·6 mm.
		174. Frontal organ, and part of antenna i., 0·6 mm.
Female.	Stage II.	175. Shell, 1·2 mm.
		176. Frontal organ, somewhat like that of *brachyaskos*, 1·2 mm.
	Stage III.	177. Shell, 0·9 mm.
		178. Frontal organ, and part of antenna i., 0·9 mm.
	Stage IV.	179. Shell, 0·7 mm.
		180. Frontal organ, and part of antenna i., 0·7 mm.
		181. Inner branch of antenna ii., 0·7 mm.
	Stage V.	182. Shell, 0·5 mm.
		183. Frontal organ. 0·5 mm.

Conchœcia pusilla, var. major, Müller.

Male.	Fig. 184. Shell, 0·8 mm.
Female.	186. Shell, 0·8 mm.



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BISCAYAN OSTRACODA.

Plate 23.

Conchœcia pusilla, var. major, Müller.

Male. Fig. 185. Inner joint of antenna ii., 0·7 mm.
Female. 187. Postero-dorsal angle of shells, from inside, 0·8 mm.

Conchœcia rhynchena, Müller.

Male. Stage II. Fig. 188. Shell, 2·5 mm.
189. Pad on proximal accessory bristle of antenna i., 2·5 mm.
Stage III. 190. Shell, 1·7 mm.
191. Frontal organ, and part of antenna i., 1·7 mm.
Stage IV. 192. Shell, 1·1 mm.
193. Frontal organ, and end of antenna i., 1·1 mm.
194. Part of antenna ii., 1·1 mm.
Female. Stage II. 195. Shell, 2·5 mm.
196. Frontal organ, with unusually blunt end, 2·5 mm.
197. Frontal organ, with unusually sharp end, and end of antenna i., 2·5 mm.
198. Frontal organ with prolonged tip, 2·4.
Stage III. 199. Shell, 1·6 mm.
200. Frontal organ, and end of antenna i. (dorsal bristle accidentally omitted), 1·6 mm.
Stage IV. 201. Shell, 1·1 mm.
202. Frontal organ, and end of antenna i., 1·1 mm.
Stage V. 203. Shell, 0·8 mm.
204. Frontal organ, and end of antenna i., 0·8 mm.

Conchœcia rotundata, Müller.

Male. Stage I. Fig. 206. Inner branch of right antenna ii., 0·9 mm.
Stage II. 208. Frontal organ, and part of antenna i., 0·7 mm.
209. Inner branch of right antenna ii., 0·7 mm.
210. Inner branch of left antenna ii., 0·8 mm.
Stage III. 212. Frontal organ, and part of antenna i., 0·6 mm.
Stage IV. 214. Frontal organ, and part of antenna i., 0·4 mm.
Female. Stage I. 216. Frontal organ, typical form, 1·2 mm.
217. The same, unusual form, resembling that of *pusilla*, 0·9 mm.
218. Inner branch of antenna ii., 1·2 mm.
Stage II. 220. Frontal organ, and part of antenna i., 0·8 mm.
Stage III. 222. Frontal organ, and part of antenna i., 0·5 mm.
Stage IV. 224. Frontal organ, and part of antenna i., 0·3 mm.

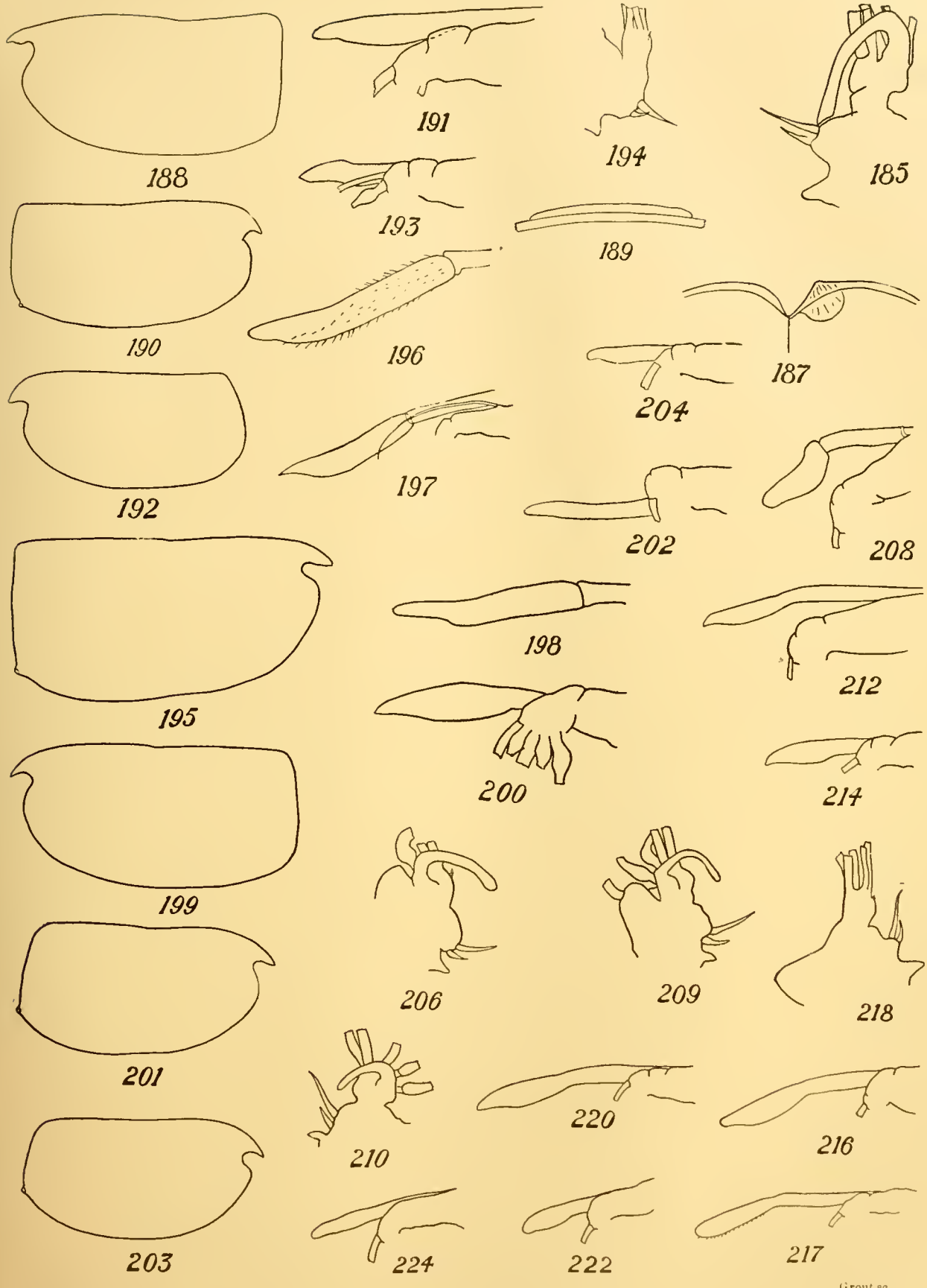

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Plate 24.

Conchœcia rotundata, Müller.

Male.	Stage I.	Fig. 205. Shell, 1·0 mm.
	Stage II.	207. Shell, 0·7 mm.
	Stage III.	211. Shell, 0·58 mm.
	Stage IV.	213. Shell, 0·4 mm.
Female.	Stage I.	215. Shell, 1·1 mm.
	Stage II.	219. Shell, 0·8 mm.
	Stage III.	221. Shell, 0·5 mm.
	Stage IV.	223. Shell, 0·3 mm.

Conchœcia spinifera, Claus.

Male.	Stage II.	Fig. 225. Shell, 1·8 mm.
	Stage III.	226. Shell, 1·4 mm.
		227. Frontal organ, and part of antenna i., 1·4 mm.
	Stage IV.	228. Shell, 1·0 mm.
		229. Frontal organ, and part of antenna i., 1·0 mm.
Female.	Stage II.	230. Shell, 2·2 mm.
		231. Inner branch of antenna ii., 2·2 mm.
	Stage III.	232. Shell, 1·4 mm.
		233. Frontal organ, and part of antenna i.
	Stage IV.	234. Shell, 1·0 mm.
		235. Frontal organ, and part of antenna i., 1·0 mm.

Conchœcia spinirostris, Claus.

Male.	Stage I.	Fig. 237. Frontal organ, 1·3 mm.
		238. A saw-tooth of the principal bristle of male antenna i. (freehand), 1·3 mm.
	Stage II.	240. Frontal organ, 1·0 mm.
		241. Inner branch of right antenna ii., 1·0 mm.
		242. Inner branch of left antenna ii., 1·0 mm.
Female.	Stage II.	244. Frontal organ, and part of antenna i., 1·2 mm.
	Stage III.	246. Frontal organ, and part of antenna i., 0·8 mm.

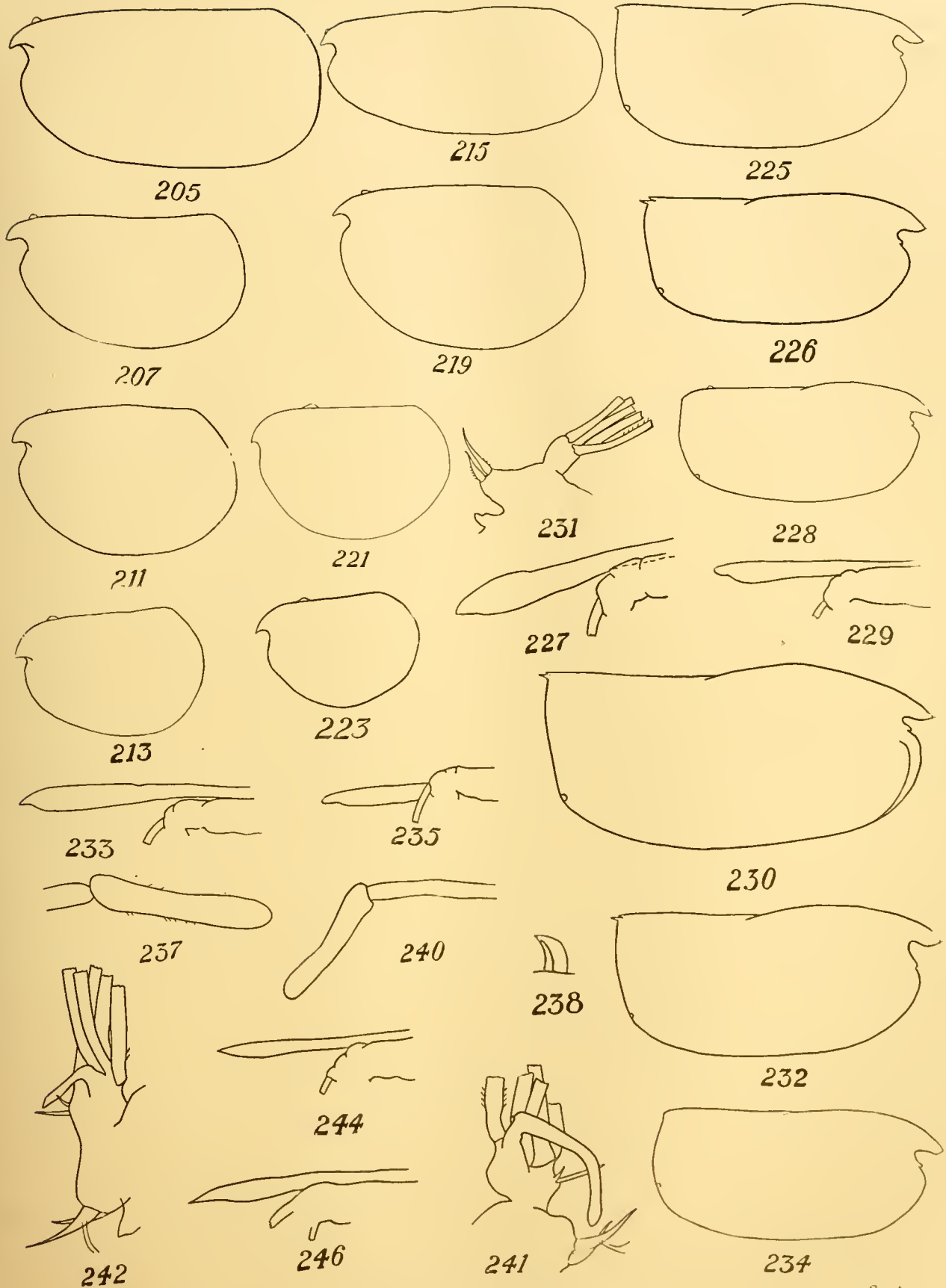

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Plate 25.

Conchœcia spinirostris, Claus.

Male.	Stage	I.	Fig. 236. Shell, 1·3 mm.
	Stage	II.	239. Shell, 1·0 mm.
Female.	Stage	II.	243. Shell, 1·2 mm.
	Stage	III.	245. Shell, 0·7 mm.

Conchœcia zetesios, sp. n.

Female.	Stage (?) I.	Fig. 247. Shell, 2·4 mm.
		248. Frontal organ, and end of antenna i., 2·3 mm.
		249. Frontal organ, from another specimen, 2·4 mm.
		250. Part of dorsal bristle, 2·3 mm.
		251. Inner branch of antenna ii., 2 5 mm.
	Stage (?) II.	252. Shell, 1·5 mm.
		253. Frontal organ, 1·5 mm.

Conchœcia B.

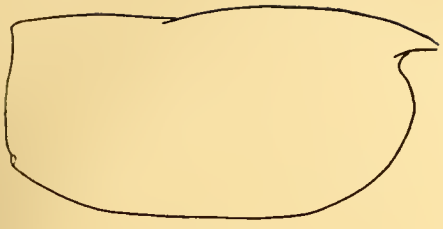
Fig. 254. The right shell, 1·7 mm.
255. The left shell.
256. Frontal organ, and part of antenna i.
257. Inner joint of antenna ii.

Conchœcia C.

Fig. 258. Shell, 1·1 mm. (rostrum slightly "restored").
259. Frontal organ.
260. Pad on accessory bristle of antenna i.
261. Inner branch of right antenna ii.
262. Inner branch of left antenna ii.

Halocypris globosa, Claus.

Male. Stage I. Fig. 263. Shell, 2·1 mm. The "peeked" line completes what is believed to be the natural contour.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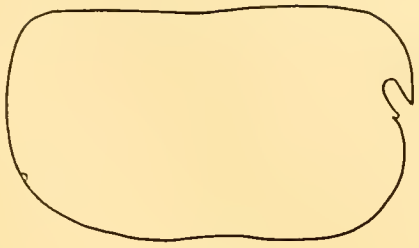
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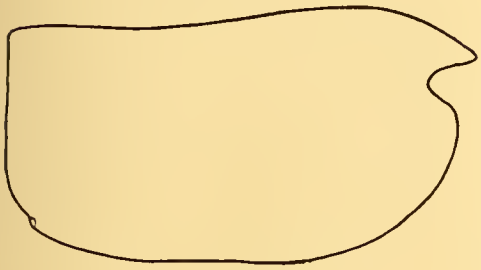
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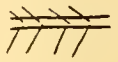
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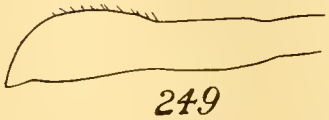
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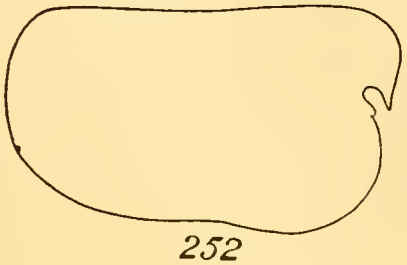
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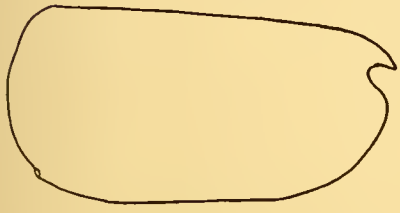
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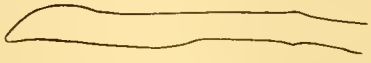
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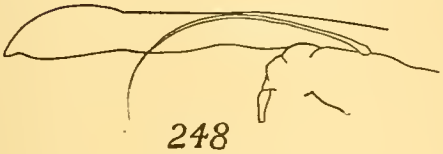
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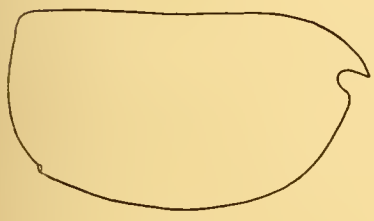
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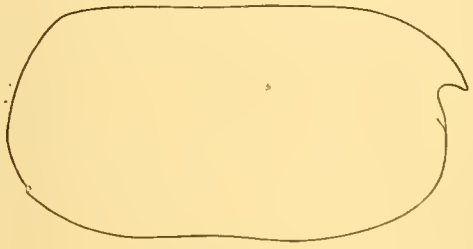
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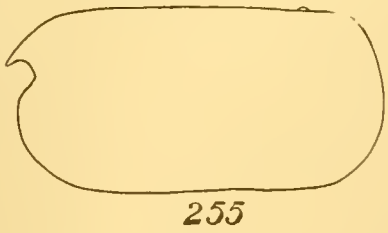
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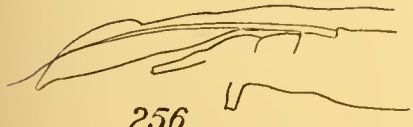
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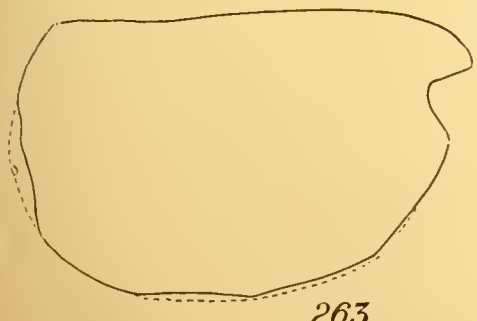
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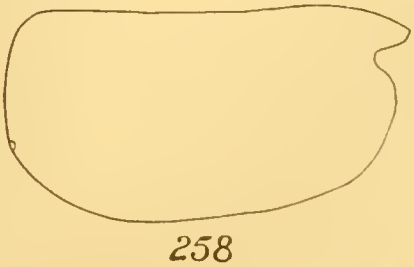
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G. H. Fowler del. Grout sc.

BISCAYAN OSTRACODA.

Plate 26.

Halocypris globosa, Claus.

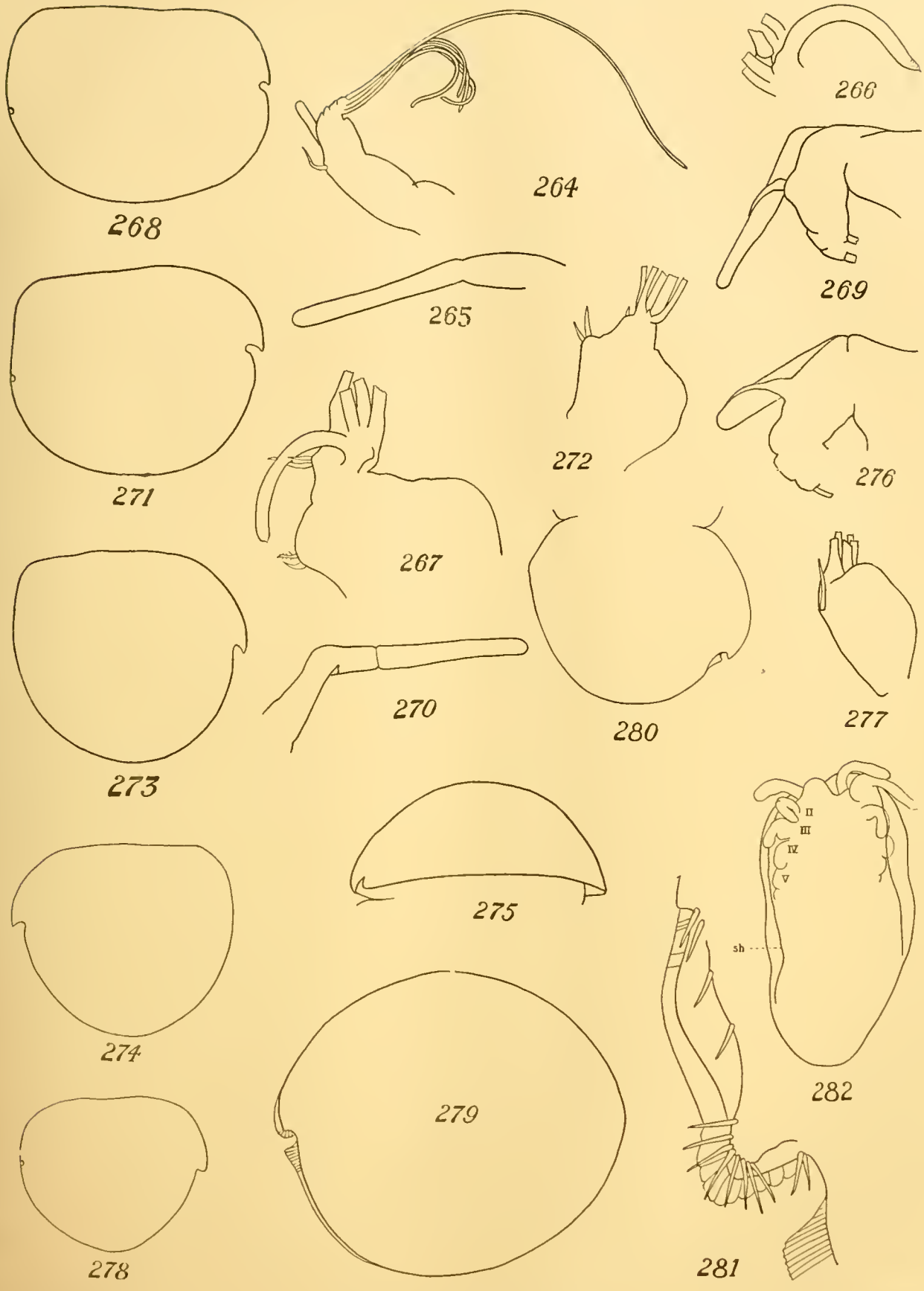
Male.	Stage I.	Fig. 264. Frontal organ and antenna i.
		265. Frontal organ.
		266. Hook of right antenna ii.
		267. Inner branch of left antenna ii.
Female.		268. Shell, 2·7 mm.
		269. Frontal organ, and part of antenna i., 2·5 mm.
		270. Frontal organ, 2·5 mm.
	Stage II.	271. Shell, 1·6 mm.
		272. Inner branch of antenna ii., 1·7 mm.
	Stage III.	273. Shell, 0·9 mm.
	Stage IV.	274. Shell, 0·6 mm.
		275. Left shell, from the ventral border, 0·6 mm.
		276. Frontal organ, and part of antenna i., 0·6 mm.
		277. Inner branch of antenna i., 0·6 mm.
	Stage V.	278. Shell, 0·4 mm.

Cypridina castanea, Brady.

? Female.	Stage IV.	Fig. 279. Shell, 1·8 mm.
		280. Shell, from inside, to show the deeply ventral position of the rostrum.
		281. The rostral region.

Gigantocypris pellucida, Müller.

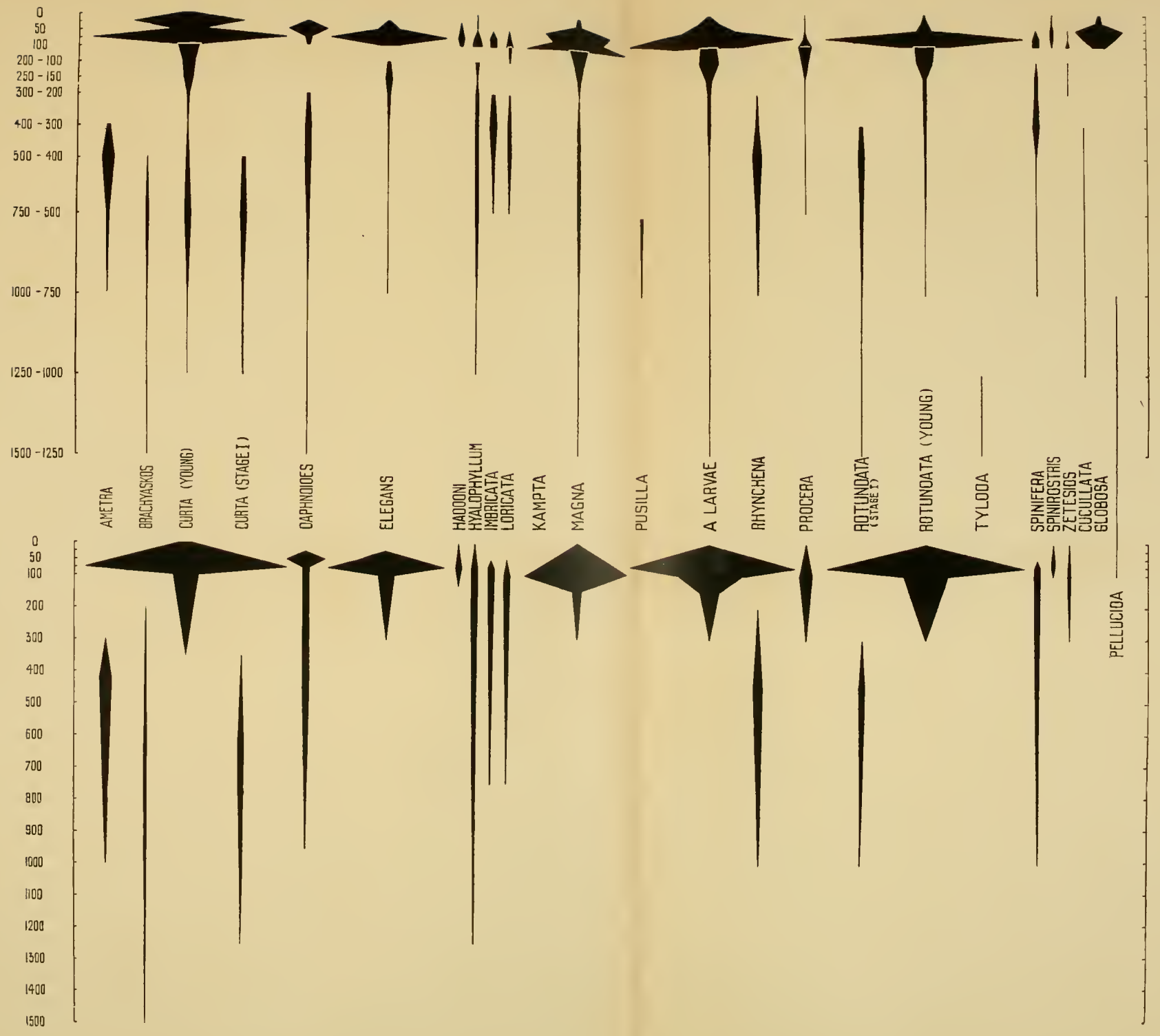
Fig. 282. Embryo of 2·1 mm. in length, showing five pairs of appendages. The edges of the shell have grown markedly downwards in the anterior part (*sh*).



G. H. Fowler del. BISCAYAN OSTRACODA. Grout sc.

Plate 27.

The upper part represents diagrammatically the observed distribution of the different species captured. The lower part represents the author's interpretation of the observed facts. For further explanation, see pages 298, 299.


0
50
100
200 - 100
250 - 150
300 - 200
400 - 300
500 - 400
750 - 500
1000 - 750
1250 - 1000
1500 - 1250
AMETRA
BRACHYASKOS
CURTA (YOUNG)
CURTA (STAGE I)
DAPHNOIDES
ELEGANS
HADOONI
HYALOPHYLLUM
IMBRICATA
LORICATA
KAMPTA
MAGNA
PUSILLA
A LARVAE
RHYNCHENA
PROCERA
ROTUNDATA (STAGE I)
ROTUNOATA (YOUNG)
TYLOOA
SPINIFERA
SPINIROSTRIS
ZETESIOS
CUCULLATA
GLOBOSA
PELLUCIDA
0
50
100
200
300
400
500
600
700
800
900
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1100
1200
1300
1400
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BISCAYAN PLANKTON.

Part XIII.—THE SIPHONOPHORA.

By Henry B. Bigelow, *Museum of Comparative Zoology, Cambridge, Mass.*

(*Communicated by* G. Herbert Fowler, *Ph.D., F.L.S.*)

(Plate 28.)

Read 3rd November, 1910.

List of Species.

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Except for a single unrecognizable rhizophysid fragment the collection consists exclusively of Calycophoræ. A similar absence of the Physophoræ in the Atlantic during the summer has been noted by Chun (1897 *b*), who has suggested that either the adults or the larvæ must be at considerable depths at this time of the year. The Biscayan collection throws no light on this question, since no larval physophorids were taken, in spite of the considerable number of hauls from comparatively great depths. The scarcity of physophorids is not a phenomenon common to the whole of the North Atlantic during the summer months, for, along the eastern coast of North America, it is during this season chiefly that they are encountered.

On geographical grounds the records are valuable, because very few siphonophores have ever been recorded from the Bay of Biscay, and because several were captured in closing-nets.

The most interesting features of the collection from the systematic standpoint are a new species of *Diphyes*, and a new genus, *Nectopyramis*, probably belonging to the Monophyidæ, but easily distinguished by structural features.

The classification followed in the ensuing pages is that proposed by Chun (1897 *b*), and since adopted by Lens and Van Riemsdijk (1908). For a very different scheme, see K. C. Schneider (1898). All the species here listed, with the single exception of

Nectopyramis thetis, are contained in the 'Albatross' Eastern Pacific Expedition; and in my report on that collection, now in press, they are more fully described and figured, and questions of synonymy and classification are discussed in greater detail than the scope of the present paper allows.

In conclusion, I may say that the excellent condition of the specimens, upon which Dr. Fowler is to be congratulated, have made their study much easier than is usually the case with preserved Siphonophores.

CALYCOPHORÆ.

MONOPHYIDÆ, Claus, 1874.

SPHÆRONECTINÆ (Huxley, 1859), Haeckel, 1888.

NECTOPYRAMIS, gen. nov.

A single nectophore, apparently a monophyid, differs in so many important features from all known Calycophoræ that it has been made the type of a new genus. *Nectopyramis* is also represented in the 'Albatross' collection by a considerable series. When I first examined the specimen I thought, from the appendages, that it might prove to be the polygastric state of the eudoxid described by Chun (1888, 1897 *b*), Bedot (1904), and Lens and Van Riemsdijk (1908) as *Ceratocymba*. But the bract, though in some respects suggesting that form, differs so much from it in the structure of its somatocyst as to forbid the union. And I may forestall my account of the 'Albatross' collection by adding that it shows strong evidence connecting *Ceratocymba* with *Abyla leuckartii*, a union the possibility of which has already been suggested by K. C. Schneider (1898).

So far as we can judge from the single available example, *Nectopyramis* may be defined as *Monophyidæ with rounded nectophore, with the somatocyst represented by a series of divergent canals: the cormidia are without special nectophores.*

NECTOPYRAMIS THETIS, sp. nov. (Pl. 28. figs. 1–4.)

Occurrence: 300 to 0 fathoms. 36 *k*. 1 specimen in excellent condition.

Nectophore.—The nectophore, which is 11 mm. in greatest length, is of a pyramidal form, so characteristic that it makes the animal noticeable at the first glance. It may be described as bounded by four equilateral triangles, with somewhat concave margins; but these triangles are hardly comparable to the facets of the cymbonectids or diphyids, because they join each other by gradual curves, instead of being separated by sharp ridges. In this regard, then, the general form is intermediate between that of such forms as *Sphæronectes* and *Halopyramis*. The gelatinous substance of the nectophore is stiff, but almost perfectly transparent.

The nectosac lies in one of the triangular faces, near its dorsal angles. It is comparatively small, shallow, and saucer-shaped, and its subumbrellar surface, though torn, is sufficiently well preserved in places to show that its musculature, like that of *Hippopodius*, is so weak that it cannot serve as a very effective swimming-organ. The hydrœcium is large, deep, and laterally compressed. It is situated immediately above the nectosac. Its opening lies along the line of junction between two of the facets, and

extends from end to end of the nectophore. The relationship of nectosac to hydrœcium, and the form of the latter, can best be seen in the accompanying photographs (figs. 1, 2).

The typical somatocyst of other monophyids is here represented by a series of canals, which form not the least interesting feature of the nectophore, and suggest the condition in *Stephanophyes superba*, Chun (1891). The arrangement of the canals is as follows:—from the point on the inner surface of the hydrœcium where the stem is attached, a canal runs on either side over the inner lateral surface of the hydrœcium, to terminate blindly before reaching its ventral margin. Each of these canals, at a point nearly opposite the dorsal margin of the nectosac, gives off a branch which runs in a direct line to the dorso-lateral angle of the nectophore. The ascending branch, corresponding in location to the ascending branch of the somatocyst of *Rosacea* and *Praya*, is so much injured that it is impossible to tell how far it extended normally. In the specimen it can be traced about halfway to the apex of the hydrœcium. The descending branch, after giving off the trunks to the lateral walls of the hydrœcial cavity, follows the dorsal margin of the hydrœcium, as in the Prayinæ; but instead of connecting with the nectosac by a single canal, as is usually the case, it sends no less than four to that structure. These canals, clearly seen in the photographs, are a pair of laterals, arising together, a dorsal and a ventral each arising separately, opposite the dorsal or ventral margin of the nectosac, as the case may be. The canals do not join the nectosac at its apex, but about at its mid-level. But in spite of their unusual arrangement, they no doubt correspond to the radial subumbral canals of more typical forms. In its further extension the descending branch of the somatocyst reaches nearly to the ventro-basal angle of the nectophore.

Stem and Appendages.—The stem is very much contracted, but when detached from the nectophore the following features could be determined. There are no buds for reserve bells, nor could I distinguish any structure suggesting that a second bell had been attached, but had been lost. The evidence of a single example, so contracted as is this one, is perhaps insufficient to make it certain that the species is a monophyid. But so far as it goes it is positive, and unless other specimens are found with posterior nectophores, or with the buds for such structures, no course is open except to refer *Nectopyramis* to the Monophyidæ. Besides a considerable number of very young appendages and buds, there is one group in which siphon, tentacle, two gonophores, and bract are well developed.

The bract is very characteristic. In general form it is saucer-shaped, or scale-like, bluntly pointed at the superior, transversely truncate at the inferior end. Though flat, there are three dorsal ridges, a single descending and two ascending, and near the centre, where the latter arise, there are two triangular prominences. The canal system of the bract consists of a single descending, and two diverging lateral branches, each of which gives off a short, nearly vertical branch running up into one of the dorsal prominences.

It thus resembles even to minor details the canal system of the bract of *Praya cymbiformis*, so often described and figured, and, though less closely, that of *Rosacea plicata*.

One of the gonophores is already of comparatively large size, and has a well-marked hydrœcial groove, limited by broad wings, but open as yet throughout its length. Except for these wings, the surface of the gonophore shows neither ridges nor distinct facets, nor are there any basal teeth. But the absence of such structures at this early stage does not necessarily imply that they are not developed later.

The spadix is extremely small—indeed, it is nothing more than a minute knob projecting downward into the bell cavity; at this early stage its sex could not be determined.

In addition to this gonophore there are two younger ones in the single cormidium preserved; both are very young, but one has a well-developed manubrium on which ova, already of considerable size, can be distinguished. In this cormidium there is no special nectophore; but it can only be settled on more extensive material whether such organs are developed later or not.

The siphon, which is relatively large and has a well-marked basigaster, presents no feature of special interest.

The basal part alone of the tentacle is still intact, and the numerous tentillæ which are attached to it are all immature. So far as their present state shows, they are of the type characteristic of *Sphæronectes* and other monophyids.

Assuming that *Nectopyramis* is a monophyid, it does not fit in very well with either of the two subdivisions of that group usually recognized, for although, so far as the form of the nectophore is concerned, it agrees well enough with the Sphæronectinæ, it differs from that subfamily, and from the Cymbonectinæ as well, in the structure of the somatocyst. In this respect the only close parallel among Calycophoræ is afforded by certain Diphyidæ, e. g. *Stephanophyes*, Chun. But the absence of any trace of a posterior nectophore forbids classing it in that family. To make further speculation as to its affinities of any real value, large series must be examined, to determine especially whether more than one nectophore is ever present.

Cymbonectinæ, Haeckel, 1888.

Muggiæa, Busch, 1851.

Muggiæa kochii (Will), Chun.

Diphyes kochii, Will, 1844, p. 77, Taf. 2. fig. 22; Busch, 1851, p. 46, Taf. 4. figs. 3–5.
Muggiæa pyramidalis, Busch, 1851, p. 48, Taf. 4. fig. 6.
Muggiæa kochii, Chun, 1882, p. 679, Taf. 16. figs. 1–7; 1892, p. 89; K. C. Schneider, 1898, p. 88.

For a complete synonymy of this species and its eudoxid, the *Ersæa pyramidalis* of Will, see Chun, 1892, p. 89.

Occurrences: 50 to 0 fathoms.	25 *g*.	10	anterior nectophores.
100 to 0 fathoms.	30 *g*, 35 *b*, 36 *b*, 36 *e*.	11	„ „
150 to 0 fathoms.	36 *f*.	3	„ „
200 to 0 fathoms.	36 *g*.	4	„ „
250 to 0 fathoms.	36 *h*.	2	„ „

All about 12 mm. long.

These nectophores, none of which are in very good condition, agree, on the whole, so

well with Chun's (1882) description and figures of *Muggiæa kochii* that I have no doubt that they belong to that species; the more so since in none of them was any trace of a posterior nectophore, or of a bud for such a structure, to be seen.

As Will (1844), Busch (1851), and Chun (1882) have all observed, the nectophore is pyramidal, with five prominent ridges, but with nothing more pronounced in the way of basal teeth than a slightly prominent dorsal ridge. One feature not mentioned by earlier students is that the lateral ridges invariably end a short distance above the basal margin. But since this fact is often masked by the incurving of the bell-margin, and can be seen in contracted material only by flattening out this region, it may well have been overlooked. In expanded specimens, particularly those in which the musculature of the subumbrella is torn away; the course and termination of the ridges is easily followed.

The somatocyst is cylindrical and reaches from one-third to one-half the height of the nectosac. Its general form is one of the readiest field-marks to separate this species from *Diphyes fowleri*, which resembles it in general appearance; its shortness, together with the shallowness of the hydrœcium, which lies almost wholly below the level of the opening of the nectosac, serve to distinguish *M. kochii* from *M. atlantica* (Cunningham, 1892).

To Chun's account I can further add that the dorsal wall of the hydrœcium below the level of the bell-opening is divided longitudinally into two nearly symmetrical wings, as in many Diphyopsinæ.

In every specimen, all but the youngest appendages were wanting. *M. kochii* has already been recorded from the Atlantic (Chun, 1888), as well as from the Mediterranean. But there is, so far as I know, no definite record of its occurrence so far north as the Bay of Biscay.

DIPHYIDÆ, Eschscholtz, 1829.

PRAYINÆ, Kölliker, 1853.

ROSACEA, Quoy et Gaimard, 1827.

ROSACEA PLICATA, Quoy et Gaimard.

Rosacea plicata, Quoy et Gaimard, 1827, p. 177, pl. 4 B. fig. 4; K. C. Schneider, 1898, p. 78.
Rosacea ceutensis (partim), Blainville, 1834, p. 140, pl. 6. fig. 8.
Praya diphyes, Kölliker, 1853 *a*, p. 33, Tab. 9; 1853 *b*, p. 306; Vogt, 1854, p. 99, pls. 16, 17; Bedot, 1882, p. 122; non Lesson, 1843, p. 144.
Diphyes bragæ, Vogt, 1851 *b*, p. 140.
Rhizophysa filiformis, Delle Chiaje, 1842, p. 135, pl. 149. fig. 3; Vogt, 1851 *b*, p. 522.
Praya filiformis, Keferstein und Ehlers, 1861, p. 20.
Lilyopsis diphyes, Chun, 1885, p. 280; 1897 *b*, p. 102; Haeckel, 1888, p. 150.
? *Rosacea ceutensis*, Quoy et Gaimard, 1827, p. 176, pl. 4 *b*. figs. 2, 3.

This species, so fully described and well figured by Vogt (1854) and by Kölliker (1853 *a*), is usually known as *Lilyopsis diphyes* (Vogt), Chun, but, as K. C. Schneider (1898) has pointed out, there is good reason to believe that it is identical with the *Rosacea plicata* found by Quoy and Gaimard in the Straits of Gibraltar. It is true that

their figure, which is of the superior nectophore only, leaves much to be desired, but, as Leuckart long ago observed, the species which they studied was undoubtedly a Prayid; while the presence of a globular swelling at the extremity of the somatocyst points strongly to its identity with the *P. diphyes* of Vogt and Kölliker, rather than with any other species of the subfamily. Nor is there anything in the original figure or description to forbid the union of the two. It is, of course, most desirable to identify the older and usually very insufficient figures and descriptions of Siphonophores with the species actually known to-day, and it seems that in the present case this can be done safely.

The name *Praya diphyes* was first used by Lesson (1843) [the quotation by Vogt of Blainville, 1834, for this name is an error] for the *Diphyes prayensis* of Quoy and Gaimard, a species founded for a single detached nectophore. It was regarded by Vogt as identical with the species he studied. But Quoy and Gaimard's figures (1834, pl. 5. figs. 37, 38), so far as they go, agree better with *P. cymbiformis*.

Occurrences: 250 to 0 fathoms.	36 *h*, 36 *i*.	6 superior,	5 inferior nectophores.			
300 to 0 fathoms.	36 *k*.	6	„	2	„	„
350 to 0 fathoms.	36 *l*.	3	„	3	„	„
1250 to 0 fathoms.	27 *a*.	1	„			
300 to 200 fathoms.	21 *c*, 26 *f*.	2	„	1	„	„

The superior nectophores range from 12 mm. to 21 mm. in length, and from 9 mm. to 17 mm. in breadth; the inferior ones from 12 mm. to 22 mm. and from 7 to 15 mm. respectively.

When the collection reached my hands all the nectophores here listed were separate. The older [inferior] and younger [superior] ones, however, are not only easily identified, but from their sizes can often be associated with each other in pairs. In all the specimens the greater part of the corm and appendages are broken off, but in one I was able to find a well-preserved special nectophore, in addition to many crowded gonophores, siphons, tentacles, and the remnants of bracts. This discovery, of course, makes its generic identification certain.

The specimens are identified with *R. plicata* (rather than with *R. medusa*, Metschnikoff 1870=*R. diphyes*, Graeffe, 1860=*R. rosea*, Chun, 1885), because of the absence of tentacular rudiments on the margin of the special nectophore. Diagnostic also is the comparatively small size of the nectosac, the short oval form of the nectophores, and the presence of well-marked hydrœcial furrows. In *R. medusa*, as clearly shown in the figures by Metschnikoff (1870) and Bedot (1895), the chief nectophores are triangular, the nectosacs relatively very large. A single colony of *R. medusa*, from the Pacific, which I have examined, agrees with these figures, in the almost total suppression of the hydrœcium. The two nectophores are merely slightly concave ventrally and closely apposed to each other.

Comparison between the Biscayan specimens and excellently preserved material of *Praya cymbiformis*, Delle Chiaje (=*P. maxima*, Gegenbaur), from both the Mediterranean and the Pacific, shows differences in the forms of the younger (superior) of the two chief nectophores, sufficient for identification, even if the stem be lacking.

In *R. plicata* the nectophore is short and broad, and the hydrœcium, which is very deep, occupies only about one-third of the ventral surface. In *P. cymbiformis*, however, as is clearly shown in Gegenbaur's (1854) excellent figures, the nectophore is proportionately longer, and the hydrœcium extends for its whole length, in the form of a groove. When specimens of the two species are placed side by side, these differences, which (though, of course, of minor importance) prove to be constant, are at once apparent. [Compare also the figures of *R. plicata* (=*P. diphyes*) by Kölliker, 1853 *a*, with those of *P. cymbiformis* (=*P. maxima*) by Gegenbaur, 1854.]

The terminal dilatation of the somatocyst in *R. plicata*, lately mentioned as a specific character by K. C. Schneider (1898), also proves to be constant. Although the contraction of preserved material may obscure it, it is more or less prominent in all the Biscayan specimens, and was observed and figured by Kölliker and by Vogt, as well as by Quoy and Gaimard, but it has never been recorded, nor have I observed it, in *P. cymbiformis*.

The appendages are too fragmentary to enable me to add to the earlier descriptions of these structures noted above. In its form, the single special nectophore which was still preserved agrees clearly with Vogt's figures.

The inferior (older) nectophores are proportionately somewhat shorter and broader than those of *P. cymbiformis*. The difference is so slight, however, that the two might be easily confused in the absence of their respective superior nectophores. The form of the hydrœcium in *R. plicata* is well shown in Vogt's figure (1854, pl. 16. fig. 3).

The entire absence of this species from any of the surface hauls, the comparatively great depths of the hauls in which it was taken, and the positive evidence of its capture in one closing-net haul between 300 and 200 fathoms, show that at least in the Bay of Biscay, at the time of the expedition of the 'Research,' it was a member of the mesoplankton, not of the epiplankton. But, inasmuch as it has been recorded previously from the surface on many occasions, its presence at a lower level cannot be regarded as indicating an invariable habitat.

Diphyopsinæ, Haeckel, 1888.

Diphyes, Cuvier, 1830.

Diphyes subtilis, Chun.

Ersæa elongata, Will, 1844, p. 82, Tab. 2. figs. 30, 31.
Monophyes irregularis (partim), Chun, 1885, p. 271, Taf. 2. fig. 3 (non Claus, 1874).
Monophyes gracilis (partim), Chun, 1885, p. 271, Taf. 2. fig. 5 (non Claus, 1874).
Diphyes subtilis, Chun, 1886, p. 449 ; 1897 *b*, p. 103 ; Lens & Van Riemsdijk, 1908, p. 47.
Monophyes diptera, Haeckel, 1888, p. 129.
Diphyes elongata, K. C. Schneider, 1898, p. 85 (non Hyndman, 1841, p. 165).

Occurrences : 25 to 0 fathoms ; 31 *a*. 1 anterior nectophore.
75 to 0 fathoms ; 32 *g*. 1 anterior nectophore.
100 to 0 fathoms ; 24 *d*, 32 *d*, 32 *p*, 35 *b*, 36 *b*. 17 anterior nectophores ; all about 5 mm. long.

The earliest name, *elongata*, cannot be used, since it was preoccupied by Hyndman for another *Diphyes*.

This species, thanks to the peculiar form of its somatocyst, with long thread-like stalk and spherical terminal dilatation, is one of the most easily recognized members of the genus. Lens and Van Riemsdijk (1908) found that the form of this organ and the rounded apex of the anterior nectophore were constant in a large series from Naples, and the 18 specimens from the Bay of Biscay are perfectly typical so far as both characters are concerned. To Chun's accounts I need only add that, in spite of a shallowness of the hydrœcium, so extreme that we may almost speak of its cavity as entirely suppressed, its dorsal wall below the level of the opening of the nectosac is divided so as to form a right and left wing, much as in *D. fowleri* and in *Muggiæa kochii*. This region is not clearly shown in Chun's figure. All of the specimens were more or less distorted; in most of them the subumbrellar musculature is destroyed and the entire stem with its appendages torn off. No inferior nectophores could be identified, nor could I find any of its eudoxids.

Diphyes subtilis is one of the most common Siphonophores in the Mediterranean, where it is an epiplanktonic form of regular occurrence. So far as I am aware, it has been recorded in the Atlantic only from the Canary Islands, where Chun (1888) found it only occasionally. It is not present in the extensive West Indian collections which I have examined. The present captures, all in open nets, are too few to warrant speculation as to its bathymetric range further than to note, as rather surprising in view of its previously known habitat, its absence from all the surface hauls. They show, however, that it is not so exclusively a subtropical form as has been supposed, for it was taken in temperatures somewhere between 52° (100 fathoms) and 66° F. (surface).

Diphyes appendiculata, Eschscholtz.

Diphyes appendiculata, Eschscholtz, 1829, p. 138, Taf. 12. fig. 7; Huxley, 1858, p. 34, pl. 1. fig. 2; K. C. Schneider, 1898, p. 85.
Diphyes bipartita, Costa, 1836, 'Genere Diphya," p. 4, Tav. 4; Chun, 1897 *b*, p. 24.
Diphyes elongata, Hyndman, 1841, p. 165, figs. 1–4.
Diphyes acuminata, Leuckart, 1853, p. 61, Taf. 3. figs. 11–20.
Diphyes sieboldii, Kölliker, 1853 *a*, p. 36, Tab. 11. figs. 1–8.
Diphyes gracilis, Gegenbaur, 1854 *a*, p. 309, Taf. 16. figs. 5–7.
? *Diphyes pusilla*, McCrady, 1857, p. 174.

In this list only the more important references are given.

I follow Huxley and K. C. Schneider in uniting in one species the Atlantic *D. bipartita* and the Pacific *D. appendiculata*, because my examination of large series from both, as well as from the Indian Ocean (Bigelow, 1904), has failed to reveal a single character to separate them.

This species and its eudoxid are so well known that I need only mention here that the collection shows that the presence of only three ridges at the apex of the anterior nectophore is constant, and that the fourth ridge, which arises some distance below the apex, invariably becomes the left lateral.

D. appendiculata is the most abundant siphonophore in the collection. Its occurrences were as follows :—

Depth in fathoms.	Number of hauls.	Anterior Nectophores.	Posterior Nectophores.	Eudoxid.
0	15	9	5	257
25	5	34	7	22
50	9	38	18	57
75	6	13	7	24
100	10	96	55	89
200–100	4	8	8	
300–200	1	1		
500–400	1	3	4	5
500–250	1	3		
		205	104	454

Fortunately the anterior and posterior nectophores are all in such good condition as to be recognized readily. But many of the eudoxids are very much battered. Only those which could be identified certainly are listed above; there are a considerable number in addition which may belong to this same species.

D. appendiculata has long been known to be a widely distributed form, not only belonging to the epiplankton, but living at very considerable depths (1300 metres, Chun, 1887; 1000 metres, Bedot, 1904). Indeed, it is perhaps the most nearly universal of all siphonophores. The captures show that its eudoxid is commonest on the surface, but that in the Bay of Biscay the polygastric generation, on the contrary, is most abundant in the zone between 100 and 25 fathoms. The scarcity of the adult on the surface is surprising, in view of the fact that it has been so commonly taken there in other localities, both tropical and temperate. Below 100 fathoms both adult and eudoxid are rare; but the excellent condition of the specimens of both forms, which were taken in the closing-net between 500 and 400 fathoms, indicates that they were alive at that depth, and not merely corpses on their way to the bottom.

Its vertical range in the region now under consideration parallels that of *Aglantha* among the Medusæ (Browne, 1906, p. 174), a genus most common between 100 and 50 fathoms, though occurring in lesser numbers at much greater depths.

D. appendiculata, like *Nausithoe punctata* among Scyphomedusæ, passes through a wide range of temperature in its distribution, both vertical and horizontal. The evidence of the present collection would suggest, for the polygastric generation, an optimum of 50°–60° F. But it occurs commonly on the surface in the tropical regions of all three great oceans, in temperatures of from 70°–78°. The most northerly record which can

safely be attributed to this species is that by the Plankton Expedition (Chun, 1897 *b*) of an eudoxid in the closing-net, 800–1000 metres, 60° 2′ N., 22° 7′ W., at a temperature of 42·8° F. (11·6° C.). Römer (1902, p. 176), it is true, records anterior nectophores from Spitzbergen. But since he says that these specimens had "Zahnartigen Vorsprönge an den untere Schirmrande," *i.e.* basal teeth, they cannot have belonged to *D. appendiculata*.

On the surface the polygastric state of this species is known from as far north as the northern coast of Ireland.

Diphyes fowleri, sp. nov. (Pl. 28. fig. 5.)

Occurrences: Surface.	21 *e*.	4	anterior nectophores.
50 to 0 fathoms.	36 *d*, 26 *c*.	4	,, ,,
75 to 0 fathoms.	33 *h*.	7	,, ,,
100 to 0 fathoms.	21 *h*, 24 *b*, 24 *d*, 24 *e*, 30 *g*, 30 *h*, 32 *d*, 35 *b*, 35 *x*, 36 *b*, 36 *e*.	39	,, ,,
250 to 0 fathoms.	36 *h*.	1	,, ,,
300 to 0 fathoms.	36 *k*.	4	,, ,,

The specimens all measured about 11 mm. in length.

I have likewise been able to study 6 anterior nectophores of this species from the West Indies, and it is represented in the 'Albatross' Eastern Pacific collection by 8. Comparison of Atlantic with Pacific specimens has revealed no differences sufficient to justify their separation.

In its general form *D. fowleri* resembles the *Diphyes subtiloides* of Lens and Van Riemsdijk (1908) so closely that only a slight difference in the structure of the hydrœcium and the shape of the somatocyst distinguish it from the latter.

Anterior Nectophore.—The diagnostic characters are as follows: there are constantly five ridges at the apex, and these, which are not prominent, run to the base without branching. In the best-preserved specimens the general form is high and narrow, but the more battered individuals are often proportionately much broader. This difference is probably to be correlated with contraction or expansion of the nectosac. There are no baso-lateral teeth, and the dorsal tooth is represented merely by a slight prominence of the dorso-basal angle. The nectosac reaches almost to the apex, and the canals follow the usual course.

The hydrœcium is an important character, since it serves to distinguish *D. fowleri* from most other diphyids. It is very short, and lies wholly below the level of the mouth of the nectosac, and is broadly conical. Its form will be more readily understood from the accompanying figure than from a verbal description. In *D. subtiloides*, although the hydrœcium is of similar outline and position according to the figures of Lens and Van Riemsdijk (1908, pl. 7), the dorsal hydrœcial wall below the bell-opening is entire, though slightly concave. But in *D. fowleri*, both from the Atlantic and from the Pacific, the wall is divided as in many diphyids, the division being to one side of the mid-line. In most instances the left-hand flap is the larger, but several of the specimens are too much distorted to show whether or not this is invariably the case.

The somatocyst is spherical or pear-shaped, and, instead of lying nearly in the longitudinal axis of the nectophore, is transverse, a form and position constant in the entire series of 73 specimens, whether Biscayan, West Indian, or Pacific. In *D. subtiloides* the somatocyst, though short, is of the usual fusiform type, merely somewhat narrower near the base, and Lens and Van Riemsdijk found no noticeable variation from this type in 110 specimens.

Stem and Appendages.—The pedicular canal of the nectosac runs almost directly downwards throughout its short course to the apex of the hydrœcium. In only one specimen was an entire group of developed appendages still attached. This consisted of bract, siphon, tentacle, and gonophore. Although the latter was sufficiently developed for identification, there was no trace of any special nectophore, and it is on this evidence that the species is referred to *Diphyes* rather than to *Diphyopsis*.

Inferior Nectophore.—None of the specimens had the second nectophore still attached, but in most of them the remnants of what was apparently the pedicular canal could be detected at the base of the stem, and it is on the strength of these that the species is referred to the Diphyidæ. There are several inferior nectophores in the collection so crumpled and distorted as to be past description or identification. It is possible that some or all of them may belong to *D. fowleri*.

The depths of capture listed above show that, though this form occurs at the surface, it is most abundant between 50 and 100 fathoms, *i. e.* in a temperature of about 52° F.

It seemed to me so unlikely that a North Atlantic species with this habitat, so easily recognized as the present, and so common as it appears to be, should so long have escaped notice, that I was loth to make it the basis for a new specific name. But examination of the literature of both Diphyids and Monophyids seems to leave no other course open.

From the Atlantic forms with baso-lateral teeth—for example, *Diphyopsis dispar*, Cham. & Eys.; *Diphyes steenstrupii*, Gegenbaur; *D. serrata*, Chun; and *Doromasia picta*, Chun,—and from the various Pacific species with this same character, to be discussed in my Report on the 'Albatross' Siphonophores, it is readily distinguished by the entire lack of such structures. The Atlantic Diphyopsinæ previously known, which agree with *Diphyes acuta* in this respect, are *D. appendiculata*, Eschsch. (=*sceboldii*, Gegenbaur, = *bipartita*, Costa); *D. arctica*, Chun; *D. subtilis*, Chun; and *Diphyopsis hispaniana*, Mayer. But from all these, as well as from *Diphyopsis mitra*, Huxley (=*D. diphyoides*, Lens and Van Riemsdijk), and *Diphyes chamissonis*, Huxley, as yet recorded only from the Indo-Pacific region, it is separated by the shortness and position of the hydrœcium, and by the structure of the somatocyst, both of which characters have proved constant. Similarly, in addition to the apparent presence of an inferior nectophore, it is separated from the monophyids *Muggiæa kochii*, Will, and *M. atlantica*, Cunningham.

Among Galeolarinæ, the only species which might perhaps agree with it with regard to the somatocyst is *Galeolaria turgida*, Gegenbaur. But in the latter the structure of the hydrœcium, and particularly the two long dorsal hydrœcial wings, are entirely different from the condition in *D. acuta*. From *G. truncata*, Sars, which somewhat

resembles it in the absence of "wings" and in general appearance, it is separated by the structure of the somatocyst, which, in the latter, is of the ordinary fusiform type and of considerable length. The only species with which it might be confused is *Diphyes subtiloides*, Lens and Van Riemsdijk; but, as noted above, it is easily distinguished from that form by its peculiar somatocyst.

Chuniphyes, Lens and Van Riemsdijk, 1908.

Chuniphyes multidentata, Lens and Van Riemsdijk.

Chuniphyes multidentata, Lens and Van Riemsdijk, 1908, p. 13, pl. 1. figs. 9–11, pl. 2. figs. 12–15.

This very interesting species is represented by 7 anterior and 8 posterior nectophores. The records of its occurrence are:

250 to 0 fathoms.	36 *h*.	1 anterior and 1 posterior nectophore.
300 to 0 fathoms.	36 *k*.	1 anterior nectophore.
1250 to 0 fathoms.	27 *a*.	1 anterior and 1 posterior nectophore.
1500 to 750 fathoms.	30 *a*.	1 anterior and 2 posterior nectophores.
1250 to 1000 fathoms.	27 *b*.	1 posterior nectophore.
2000 to 1000 fathoms.	30 *e*.	3 anterior and 3 posterior nectophores.

The 'Siboga' specimens (1 anterior and 1 posterior nectophore) from which *Chuniphyes* was originally described were so much distorted as to make its general structure seem more unusual than it actually is. In point of fact, it differs in no essential feature from other Diphyids, although the unusual number and arrangement of the ridges and the peculiar form of the hydrœcium and somatocyst justify the retention of *Chuniphyes* as a distinct genus. The pyramidal shape of the nectophores and the form of the hydrœcium strongly suggest that its affinities are with the Diphyopsinæ rather than the Galeolarinæ. Unfortunately, however, neither the 'Siboga,' the 'Albatross,' nor the present specimens afford any information as to the structure of the groups of appendages, and until we know whether they are set free as eudoxids, or remain permanently attached to the stem, it is impossible to settle this point definitely.

Comparison, side by side, between the Biscayan and the 'Albatross' Eastern-Pacific specimens of *Chuniphyes* fails to show any differences sufficient to separate them into two distinct species. And inasmuch as both these series agree with Lens and Van Riemsdijk's description of the 'Siboga' material, so far as the poor condition of the latter allows one to judge, all must be referred to the one species, *C. multidentata*. This form is described and figured in detail in my report on the 'Albatross' Siphonophores, but to make its identification easy, the more diagnostic characters may be repeated here.

The anterior nectophore of *C. multidentata* may be distinguished at first glance by its pyramidal form, by its prominent ridges, and by the peculiar form of its obliquely truncate base. At the sharp-pointed apex there are four ridges: 1 dorsal, 1 ventral, and a lateral on each side. A short distance below the apex the dorsal and the two laterals each branch dichotomously, so that there are seven at the base.

The facets are a triangular dorsal, enclosed by the two branches of the dorsal ridge, and on either side three laterals; the dorso-lateral and the median-lateral being

triangular, the ventro-lateral irregular in outline. Of these, only dorso- and ventro-laterals extend to the apex. The ventral ridge does not branch, and there is no true ventral facet, although Lens and Van Riemsdijk speak of the hydrœcium as such. Each ridge, except the ventral, terminates in a pronounced tooth, and there is in addition a tooth breaking the basal outline of the median lateral facet.

The nectosac extends upward slightly beyond the mid-level of the nectophore, and is rounded apically. In the Biscayan material it is somewhat longer than in the Pacific specimens. But in view of the possibilities of distortion through contraction, and of the fact that all of the specimens are more or less battered, such a slight difference does not justify specific separation. The course of the subumbrellar canals is of the usual type.

The hydrœcium reaches to about the same level as the nectosac, not to the apex as described by Lens and Van Riemsdijk. Along its ventral face it is open for its whole length, and its deepest point is opposite the mid-level of the nectosac.

The somatocyst is of peculiar form, in that shortly above its point of origin it becomes much dilated and then contracts once more to run as a narrow tube nearly to the apex. In the form of this dilatation there is a slight difference between Biscayan and Pacific specimens. In the only one of the latter in which it is intact it is spherical. In four of the Biscayan specimens it projects on either side in a short transverse horn. In one Atlantic specimen, however, the horns are so much smaller as to suggest a transition to the condition in the Pacific material; therefore I consider this divergence of no more importance than the slight difference in the form of the nectosac in the two collections.

The identification of the inferior nectophores listed above, all of which were detached, is made certain by their close resemblance to the corresponding nectophores of two entire colonies in the 'Albatross' collection. Their general form, especially the open hydrœcium, covered only near the apex by two short flaps, the six prominent ridges (only four at apex), and the asymmetry of the basal teeth, of which the right ventral is much the largest, still serve for identification. In both nectophores the unusual prominence and brownish colour of the ridges, already noted by Lens and Van Riemsdijk and very noticeable in the 'Albatross' specimens, form good external field marks for this species.

Chuniphyes has never been taken on the surface; the 'Albatross' records are both from 300–0 fathoms.

The present captures show a range, at the least, from 1000–250 fathoms. Especially instructive are the closing-net records of 1250–1000, 2000–1000, and 1500–750 fathoms, since, of course, they show that the material actually came from these zones. How near this species may have come to the surface cannot, of course, be absolutely determined. But its absence from all hauls from depths of less than 250 fathoms suggests that the latter level is near the upper limit of its distribution. The number of specimens taken is far too small to justify any conclusion as to its relative abundance at different depths.

POLYPHYIDÆ, Chun, 1882.

Hippopodius, Quoy et Gaimard, 1827.

Hippopodius hippopus (Forskål), Schneider.

Gleba hippopus, Forskål, 1776, p. 14, Taf. 43. fig. E.
Gleba excisa, Otto, 1823, p. 309, Taf. 42. fig. 3 *a–d*.
Hippopodius luteus, Quoy et Gaimard, 1827, p. 172, pl. 4 A. figs. 1–12; Chun, 1897 *b*, p. 34.
Hippopodius mediterraneus, Costa, 1836, "genere ippopodio," p. 3, Tav. 2.
Hippopodius neapolitanus, Kölliker, 1853 *a*, p. 28, Taf. 6. figs. 1–5.
Hippopodius gleba, Leuckart, 1854, p. 299, Taf. 12. figs. 1–5.
Hippopodius hippopus, K. C. Schneider, 1898, p. 82.

In this list only the more important references are given. For a more extended bibliography, see Chun (1897 *b*, p. 34).

I am quite willing to admit that, as has often been pointed out, Forskål's two figures, on which his name *Gleba hippopus* is based, are so lacking in detail that it is impossible to reach any altogether satisfactory identification of them. But the probability that they belong to the well-known form so often described as *Hippopodius luteus* is so strong that I believe K. C. Schneider was justified in substituting the name *hippopus* for *luteus*, as a doubtful synonym of which it is listed by Chun (1897 *b*). To do so will no doubt add stability to the nomenclature of the genus, for until *hippopus* is connected with some actual species it will continue to be a source of confusion. Even if *hippopus* be not adopted, *luteus*, used both by Chun (1897 *b*) and by Lens and Van Riemsdijk (1908), cannot be employed, because both these authors list as a synonym Otto's name *excisa*, which antedates *luteus*.

Occurrence: 300 to 0 fathoms. 36 *k*. 6 loose nectophores.

It is surprising that the definitive nectophores of this species so common in the Mediterranean and so often recorded from the warmer parts of the Atlantic, as far north as the British coast (Chun, 1897 *b*), should have been taken only in one haul. The material, moreover, was in very poor condition. In addition to these definitive nectophores, the spherical primary nectophores, so well described by Chun (1897 *a*), were taken as follows:—

75 to 0 fathoms.	34 *c*.	7	specimens.
100 to 0 fathoms.	35 *f*.	1	,,
200 to 0 fathoms.	36 *g*.	2	,,
300 to 0 fathoms.	36 *k*.	5	,,
150 to 50 fathoms.	21 *p*.	1	,,
250 to 150 fathoms.	35 *p*.	1	,,

They are all at the stage at which the bud for the first definitive nectophore is first visible (Chun, 1897 *a*, fig. 6 *a*), and in each the stem bears a single large terminal siphon, with tentacle, and one or two small buds for future siphons. In their spherical form, shallow nectosac, and deep and narrow hydrœcial furrow, they agree very well with Chun's figure; but while he records 7 mm. as the greatest diameter, one of the present series has attained the remarkable size of 10 mm. It is interesting to observe that this

species was not taken in any of the surface hauls. Chun (1887) has already recorded the adult from various depths from the surface to 1200 metres. And according to his observations the larval "primary" nectophores apparently occur on the surface only rarely. But the fact that in the Bay of Biscay they were most numerous between 75 fathoms and the surface shows that there, at least, they were members of the epiplankton. Nor do any of the present records demonstrate its occurrence much below 150 fathoms, between which depth and 250 fathoms a single example was taken in the closing-net.

Vogtia, Kölliker, 1853.

Vogtia pentacantha, Kölliker.

Vogtia pentacantha, Kölliker, 1853 *a*, p. 31, Tab. 8; Keferstein und Ehlers, 1861, p. 23, Taf. 5. figs. 12–15; Chun, 1897 *b*, p. 35, Taf. 1. figs. 11–14.

Hippopodius pentacanthus, Claus, 1863, p. 551, Taf. 47. figs. 23–25; K. C. Schneider, 1898, p. 84.

Occurrence: 350 to 0 fathoms. 36 *l*. A colony with 6 nectophores, but with only the basal remnants of the stem intact.

The chief difference between this species and *V. spinosa*, Keferstein and Ehlers (= *V. köllikeri*, Haeckel), is that in the former the spine-like gelatinous processes characteristic of the genus are restricted to the angles or ridges of the nectophores, whereas in the latter they occur closely crowded over the flat lateral surfaces as well. The evidence afforded by the specimens recorded by Chun from the Plankton expedition, and especially actual comparison between the present example and the large series of typical *spinosa* in the 'Albatross' Eastern Pacific collection, and with the few nectophores described below as probably belonging to that species, points to the validity of this difference as a specific distinction. Furthermore, the shape of the older nectophores in the two species is different, those of *spinosa* being flatter and more regular than they are in *pentacantha*. We must, however, admit that to determine the constancy of these characters will require the examination of a considerable series of *V. pentacantha*. And until this is done, the question whether *pentacantha* and *spinosa* are distinct, or merely represent two phases of one species, must remain without a final answer. The attachment of the nectophores in two alternating rows follows the same plan as in the better-known genus *Hippopodius*, with which the *Vogtia* was confused by Gegenbaur (1860) and Claus (1863). Unfortunately, only the basal end of the stem, with a very few small buds, is still intact. Therefore no description of the appendages is possible.

? Vogtia spinosa, Keferstein and Ehlers.

Vogtia spinosa, Keferstein und Ehlers, 1861, p. 24, pl. 5. fig. 16; Chun, 1897 *b*, p. 103.

Vogtia köllikeri, Haeckel, 1888, p. 182, pl. 29. figs. 9–14.

Occurrences: 200 to 0 fathoms. 36 *g*. 4 detached nectophores.
250 to 150 fathoms. 35 *p*. 8 ,, ,,

These nectophores are all somewhat distorted, and several of them badly flattened and torn. All of them, however, show more or less clearly the spinous processes on the flat

marginal surfaces characteristic of *V. spinosa* and well figured by Haeckel (1888). The similarity between them and the Pacific series of *spinosa* is a further reason for identifying them provisionally as that species. *V. spinosa* has been previously recorded only from off the coast of Brazil (Keferstein and Ehlers) and from the South Atlantic (37° 3′ S., 44° 17′ W., Haeckel).

RHIZOPHYSALIÆ.

A single fragmentary rhizophysid was taken at Station 24*f*′, surface; probably on the wire. But unfortunately it consisted only of three fragments of the stem, without any of the appendages, and therefore cannot be identified, even generically.

BATHYMETRIC DISTRIBUTION.

The number of specimens of each species sent to me from each of the various horizons is given in the accompanying table [in the case of the diphyids only the anterior nectophores are included, to prevent duplication].

Depth in fathoms	0.	25—0.	50—0.	75—0.	100—0.	150—0.	150—50.	150—100.	200—0.	200—100.	250—0.	250—150.	300—0.	300—200.	350—0.	400—300.	500—250.	500—400.	750—500.	1000—750.	1250—0.	1250—1000.	1500—750.	1500—1250.	2000—1000.	2000—1500.
Nectopyramis thetis	..	..	..	..	..	..	..	..	..	..	..	..	1													
Muggiæa kochii	..	..	10	..	11	3	..	..	4	2																
Rosacea plicata	..	..	..	..	..	..	..	..	..	..	6	..	6	2	3	..	..	..	..	..	1					
Diphyes subtilis	..	1	..	1	17																					
„ *appendiculata*	9	34	38	13	96	..	..	..	..	8	..	..	..	1	..	..	3	3								
„ „ eudoxid	257	22	57	24	89	..	..	..	..	..	..	..	..	..	..	..	..	5								
„ *fowleri*	4	..	4	7	39	..	..	..	1	..	..	..	4													
Chuniphyes multidentata	..	..	..	..	..	..	..	..	.	..	1	..	1	..	..	..	..	..	..	..	1	1	1	..	3	
Hippopodius hippopus	..	..	..	..	..	..	..	..	..	..	..	..	1													
„ „ larva	..	..	..	7	1	..	1	..	2	..	..	1	5													
Vogtia pentacantha	..	..	..	..	..	..	..	..	..	..	..	..	1													
„ *spinosa*	..	..	..	..	..	..	..	..	1	..	..	1														
Rhizophysid fragment	1																									

(NOTE.—The smaller Calycophoræ are very delicate; they were peculiarly often caught up in clots of plankton, caused by the branching spines of Phæodarian Radiolaria or by silk threads from the tow-net, from which they could only be released—if at all—in

a hopelessly tattered state. It was therefore impossible satisfactorily to sort out, from the material captured, anything like the total number of specimens present. Consequently the number of specimens from any haul, sent to Mr. Bigelow, can only be taken to indicate the comparative abundance or scarcity of a species in the very roughest and most general way. Some deductions as to their distribution may, nevertheless, fairly be drawn from the number of hauls in which they occurred. For reasons given in earlier papers of this series, we must omit, as unfair for comparison with ordinary nets, the nine hauls made at the surface with silk of 180 meshes per linear inch ; there remain 16 hauls at this horizon for comparison ; for other reasons 35 *c* (75 fathoms) and 35 *d* (100 fathoms) are also omitted. Otherwise the numbers of hauls shown on the general table (p. 358) remain good, since there seems no reason to omit the hauls with a silk at 18 meshes per inch, in the case of these comparatively large forms.—G. H. F.)

The only species taken with sufficient regularity to allow its vertical distribution to be worked out in any detail is *Diphyes appendiculata* and its eudoxid.

The polygastric stage occurred between the surface and 200 fathoms

At	0	fathoms	in 18	per cent.	of the total number of comparable hauls.	
25—0	„	25	„	„	„	„
50—0	„	38	„	„	„	„
75—0	„	50	„	„	„	„
100—0	„	42	„	„	„	„

Between 200 and 100 fathoms in 57 per cent. of the total number of comparable hauls.

Below 200 fathoms it was taken in the only closing trawl made between 500 and 250, and in one each of the three closing-nets hauled from 300 to 200 and from 500 to 400 fathoms. It did not occur in any open net from a depth greater than 100 fathoms.

This table shows very clearly that *D. appendiculata* was not common on the surface, and the preceding one, actual numbers of specimens sorted out, emphasizes this fact even more strongly. On the other hand, it is obviously very rare below 200 fathoms, its only record from below that depth being in the three closing-nets, between 200 and 500 fathoms. The tables suggest that it was most abundant between 75 and 100 fathoms. It is true that the largest number of captures in proportion to hauls is from 200–100 fathoms; but since the total number of hauls at that zone was only seven, and the total number of specimens small, it is not so safe to draw inferences from them as from the 100-fathom hauls, of which there were over three times as many. But the excellent condition of the specimens taken at 200–100 fathoms shows that they were actually living at that depth.

That the polygastric stage of *D. appendiculata* occurred in none of the eight open-net hauls from below 100 fathoms is rather remarkable, since in their passage upward the nets must, of course, have passed through the zone where the species was most plentiful. As pointed out above (p. 345) the sporadic occurrence of this form in the closing-net at considerable depth is not surprising in view of the previous records of its capture.

The eudoxid of *D. appendiculata* was taken

At	0	fathoms in	68	per cent. of the total number of comparable hauls.		
25—0	,,	16	,,	,,	,,	,,
50—0	,,	23	,,	,,	,,	,,
75—0	,,	20	,,	,,	,,	,,
100—0	,,	14	,,	,,	,,	,,

and in one haul only at all depths below 100 fathoms.

The eudoxid, then, as already noted, is evidently most abundant at or near the surface, and there is nothing to show that the captures in open nets hauled from 25, 50, 75, or 100 fathoms did not come from near the surface, while the net was on its way upward *. The sporadic occurrence of this form at 400–500 fathoms (one closing-net, five specimens) was unexpected. The material is in excellent condition, with well-developed sexual products, and the fact that it was taken in the same haul with three excellent specimens of the polygastric generation suggests that the species was not only alive, but reproducing itself at that depth.

In general, the table of captures shows a great poverty of Siphonophores at the surface in the region studied, the only records from that zone being *Diphyes appendiculata* and its eudoxid, four specimens of *D. fowleri*, and a Rhizophysid fragment.

The greatest abundance of *Muggiæa kochii*, *Diphyes subtilis*, *D. appendiculata* (Polygastric), and *D. fowleri* was evidently between 100 fathoms and 25 fathoms. Though *Rosacea plicata* was taken only below 200 fathoms, it has previously been recorded from the surface, and I have studied specimens from the Pacific taken at the surface. *Chuniphyes multidentata*, on the other hand, has so far been recorded only from considerable depths (p. 349), and is in all probability a typical representative of the permanent Mesoplankton or Intermediate fauna.

* [I have dealt with this point elsewhere. In cases where the matter can be checked statistically, it is apparent that, down to something like 100 fathoms, the contamination of the sample obtained by hauling horizontally at (say) 50 fathoms for half an hour through something like half a mile of water, by the fauna of the comparatively insignificant distance of the vertical haul to the surface, is negligible.—G. H. F.]

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EXPLANATION OF PLATE 28.

Reference letters.

Br. Bract.
C^1, C^2, C^3, C^4. Bracteal canals.
C.D.R., *C.D.L.* Right and left dorsal somatic canals.
C.A. Ascending somatic canal.
C.H.R., *C.H.L.* Right and left hydrœcial canals.
C.Ra. Radial canal of the nectosac.
H. Hydrœcium.
N.S. Nectosac.
R^1, R^2, R^3. Bracteal ridges.
R.D., *R.V.*, *R.L.* Dorsal, ventral, and lateral ridges.
SO. Somatocyst.

Figs. 1–4. *Nectopyramis thetis*, sp. nov.

Fig. 1. Somewhat oblique lateral view. The heavy dotted line indicates the position of the basal portion of the stem. From a slightly retouched photograph. × 6.

Fig. 2. Dorsal view. From a slightly retouched photograph. × 6.

Fig. 3. Bract, dorsal aspect. From a camera lucida drawing. × 35.

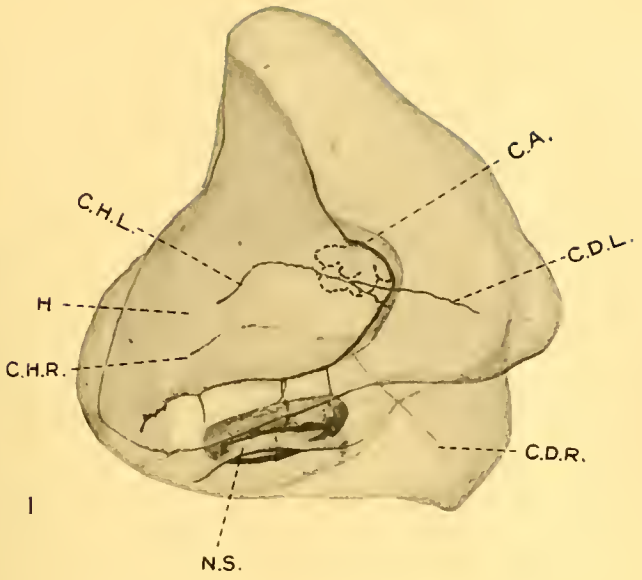
Fig. 4. Bract and gonophores. Slightly oblique lateral view. From a retouched photograph. × about 35.

Fig. 5. *Diphyes fowleri*, sp. nov. Lateral view. Based on a camera lucida drawing. × about 10.

Depth in fathoms.	Haul.	*Muggiæa kochii.*	*Rosacea plicata.*	*Diphyes subtilis.*	*Diphyes appendiculata.*	*Diphyes fowleri.*	*Chuniphyes multidentata.*	*Hippopodius hippopus.*
500—250	29 *a*	..	..	..	+			
1500—750	30 *a*	..	..	..	..	..	+	
2000—1000	30 *e*	..	..	..	..	..	+	
0	21 *e*	..	..	..	+	+		
	21 *i*	..	..	..	+			
	22 *d*	..	..	..	+			
	22 *g*							
	23 *b*	..	..	..	+			
	23 *d*	..	..	..	+			
	23 *e*	..	..	..	+			
	24 *f*							
	24 *g*	..	..	..	+			
	24 *i*	..	..	..	+			
	25 *b*	..	..	..	+			
	25 *h*	..	..	..	+			
	25 *i*	..	..	..	+			
	25 *l*	..	..	..	+			
	30 *c*							
	33 *b*	..	..	..	+			
25—0	26 *a*							
	30 *b*							
	30 *m*							
	31 *a*	..	..	+				
	32 *b*	..	..	..	+			
	32 *e*	..	..	..	+			
	33 *e*	..	..	..	+			
	33 *g*	..	..	..	+			
	34 *a*	..	..	..	+			
	34 *g*							
	35 *w*							
	36 *c*							
50—0	21 *g*	..	..	..	+			
	25 *e*							
	25 *g*	+	..	..	+			
	25 *k*							
	26 *c*	..	..	..	+	+		
	30 *d*	..	..	..	+			
	30 *l*							
	31 *b*	..	..	..	+			
	32 *a*	..	..	..	+			
	32 *h*	..	..	..	+			
	33 *c*							
	33 *f*	..	..	..	+			
	36 *d*	..	..	..	..	+		
75—0	30 *f*	..	..	..	+			
	32 *g*	..	..	+				
	32 *m*	..	..	..	+			
	32 o	..	..	..	+			
	33 *h*	..	..	..	..	+		
	34 *c*	..	..	..	..	..	..	+
	35 *a*	..	..	..	+			
	35 *c*	..	..	..	+			
	35 *e*	..	..	..	+			
	35 *y*							
	36 *a*							
100—0	21 *h*	..	..	..	..	+		
	21 *l*							
	22 *a*							
	24 *b*	..	..	..	..	+		
	24 *d*	..	..	+		*		

Depth in fathoms.	Haul.	*Muggiæa kochii.*	*Rosacea plicata.*	*Diphyes subtilis.*	*Diphyes appendiculata.*	*Diphyes fowleri.*	*Chuniphyes multidentata.*	*Hippopodius hippopus.*
100—0	24 *e*	..	..	..	+	+		
	25 *d*							
	30 *g*	+	..	..	+	+		
	30 *h*	..	..	..	+	+		
	32 *d*	..	..	+	..	+		
	32 *i*	..	..	..	+			
	32 *n*	..	..	..	+			
	32 *p*	..	..	+				
	33 *d*							
	34 *b*							
	34 *d*	..	..	..	+			
	35 *b*	+	..	+	+	+		
	35 *d*	..	..	..	+			
	35 *f*	..	..	..	+	..	..	+
	35 *x*	..	..	..	..	+		
	36 *b*	+	..	+	..	+		
	36 *e*	+	..	..	..	+		
150—0	36 *f*	+						
150—50	21 *p*	..	..	..	..	..	..	+
150—100	21 *n*							
200—0	21 *a*							
	36 *g*	+	..	..	..	..	..	+
200—100	21 *b*	..	..	..	+			
	21 o							
	26 *e*	..	..	..	+			
	34 *h*							
	35 *m*	..	..	..	+			
	35 *n*	..	..	..	+			
	35 *t*							
250—0	36 *h*	+	+	..	..	+	+	
	36 *i*	..	+					
250—150	35 o							
	35 *p*	..	..	..	..	..	..	+
	35 *s*							
300—0	36 *k*	..	+	..	..	+	+	+
300—200	21 *c*	..	+	..	+			
	26 *f*	..	+					
	35 *l*							
350—0	36 *l*	..	+					
400—300	21 *k*							
	32 *l*							
	35 *k*							
500—400	21 *m*							
	35 *h*							
	35 *i*	..	..	..	+			
750—500	22 *b*							
	30 *k*							
	34 *e*							
	34 *f*							
1000—750	23 *a*							
	27 *c*							
	31 *d*							
	32 *f*							
	32 *k*							
1250—1000	24 *a*							
	27 *b*	..	..	..	..	..	+	
	31 *c*							
1500—1250	25 *f*							
	30 *i*							
2000—1500	25 *c*							
	26 *b*							

* *Note.*—The first three hauls were made with the mesoplankton trawl.



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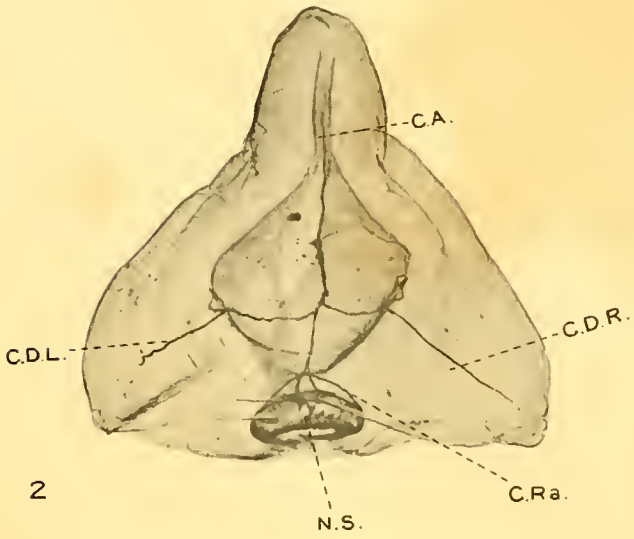

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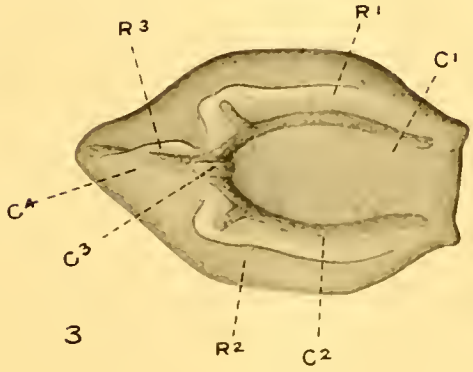

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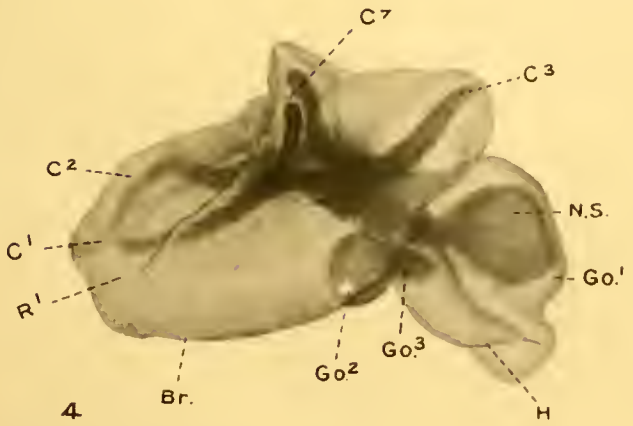

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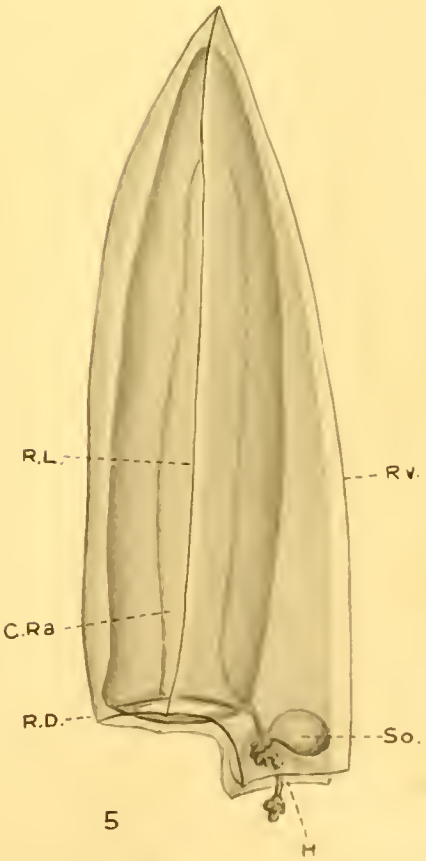

5

Bigelow, del. et Photo

BISCAYAN SIPHONOPHORA.

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BY

G. HERBERT FOWLER, B.A., Ph.D., F.L.S., F.Z.S.

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BY

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AND AN APPENDIX ON THEIR DISTRIBUTION

BY

G. HERBERT FOWLER, B.A., PH.D., F.L.S., F.Z.S.

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Part	II. 1900.	0	10	0	0	7	6
Part	III. 1900.	0	10	0	0	7	6
Part	IV. 1901.	0	14	0	0	10	6
Part	V. 1901.	0	5	0	0	3	9
Part	VI. 1901.	0	10	0	0	7	6
Part	VII. 1901.	1	8	0	1	1	0
Part	VIII. 1902.	0	4	0	0	3	0
Part	IX. 1902.	0	5	0	0	3	9
Part	X. 1903.	1	0	0	0	15	0
Part	XI. 1903.	0	6	0	0	4	6
Part	XII. 1903.	0	10	0	0	7	6
Part	XIII. Index.	0	2	9	0	2	3
IX. Part	I. 1903.	0	9	0	0	6	9
Part	II. 1903.	0	8	0	0	6	0
Part	III. 1903.	1	4	0	0	18	0
Part	IV. 1904.	0	6	0	0	4	6
Part	V. 1904.	0	6	0	0	4	6
Part	VI. 1904. (In Progress.)	0	6	0	0	4	6
X. Part	I. 1904.	0	3	0	0	2	3
Part	II. 1904.	0	8	0	0	6	0

THE

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Part III.—THE CHÆTOGNATHA.

BY

G. HERBERT FOWLER, B.A., Ph.D., F.L.S., F.Z.S.

LONDON:

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SECOND SERIES.—ZOOLOGY.

Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
I. Part	I. 1875.	1	4	0	0	18	0
Part	II. 1875.	0	6	0	0	4	6
Part	III. 1876.	1	8	0	1	1	0
Part	IV. 1877.	0	16	0	0	12	0
Part	V. 1877.	0	18	0	0	13	6
Part	VI. 1877.	1	2	0	0	16	6
Part	VII. 1878.	1	16	0	1	7	0
Part	VIII. 1879.	1	0	0	0	15	0
II. Part	I. 1879.	1	4	0	0	18	0
Part	II. 1881.	0	15	0	0	11	6
Part	III. 1882.	1	8	0	1	1	0
Part	IV. 1882.	0	7	6	0	5	6
Part	V. 1882.	0	3	0	0	2	3
Part	VI. 1883.	1	0	0	0	15	0
Part	VII. 1883.	0	5	0	0	3	9
Part	VIII. 1883.	0	3	0	0	2	3
Part	IX. 1883.	0	3	0	0	2	3
Part	X. 1884.	0	4	6	0	3	6
Part	XI. 1884.	0	10	0	0	7	6
Part	XII. 1885.	0	6	0	0	4	6
Part	XIII. 1884.	0	6	0	0	4	6
Part	XIV. 1885.	0	6	0	0	4	6
Part	XV. 1885.	0	4	6	0	3	6
Part	XVI. 1885.	0	5	0	0	3	9
Part	XVII. 1886.	0	3	0	0	2	3
Part	XVIII. 1888.	0	2	6	0	2	0
III. Part	I. 1884.	1	14	0	1	5	6
Part	II. 1884.	1	12	0	1	4	0
Part	III. 1885.	1	10	0	1	2	6
Part	IV. 1885.	0	8	0	0	6	0
Part	V. 1887.	0	8	0	0	6	0
Part	VI. 1888.	0	6	0	0	4	6
IV. Part	I. 1886.	1	4	0	0	18	0
Part	II. 1887.	1	8	0	1	1	0
Part	III. 1888.	0	16	0	0	12	0
V. Part	I. 1888.	0	12	0	0	9	0
Part	II. 1888.	0	5	0	0	3	9
Part	III. 1889.	1	7	0	1	0	0
Part	IV. 1890.	0	12	0	0	9	0
Part	V. 1890.	0	6	0	0	4	6
Part	VI. 1891.	0	12	0	0	9	0
Part	VII. 1891.	0	6	0	0	4	6
Part	VIII. 1892.	0	8	0	0	6	0
Part	IX. 1892.	0	12	0	0	9	0
Part	X. 1893.	1	8	0	1	1	0

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Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
V. Part	XI. 1894.	0	2	6	0	2	0
VI. Part	I. 1894.	2	0	0	1	10	0
Part	II. 1894.	1	11	0	1	3	3
Part	III. 1894.	0	10	0	0	7	6
Part	IV. 1896.	1	4	0	0	18	0
Part	V. 1896.	0	10	0	0	7	6
Part	VI. 1896.	0	8	0	0	6	0
Part	VII. 1896.	0	12	0	0	9	0
Part	VIII. 1897.	0	2	6	0	2	0
VII. Part	I. 1896.	0	10	0	0	7	6
Part	II. 1897.	0	12	0	0	9	0
Part	III. 1897.	0	6	0	0	4	6
Part	IV. 1898.	0	10	0	0	7	6
Part	V. 1898.	0	18	0	0	13	6
Part	VI. 1898.	0	13	0	0	9	9
Part	VII. 1899.	0	18	0	0	13	6
Part	VIII. 1899.	0	12	0	0	9	0
Part	IX. 1899.	1	0	0	0	15	0
Part	X. 1900.	0	6	0	0	4	6
Part	XI. 1900.	0	2	9	0	2	0
VIII. Part	I. 1900.	0	10	0	0	7	6
Part	II. 1900.	0	10	0	0	7	6
Part	III. 1900.	0	10	0	0	7	6
Part	IV. 1901.	0	14	0	0	10	6
Part	V. 1901.	0	5	0	0	3	9
Part	VI. 1901.	0	10	0	0	7	6
Part	VII. 1901.	1	8	0	1	1	0
Part	VIII. 1902.	0	4	0	0	3	0
Part	IX. 1902.	0	5	0	0	3	9
Part	X. 1903.	1	0	0	0	15	0
Part	XI. 1903.	0	6	0	0	4	6
Part	XII. 1903.	0	10	0	0	7	6
Part	XIII. Index.	0	2	9	0	2	3
IX. Part	I. 1903.	0	9	0	0	6	9
Part	II. 1903.	0	8	0	0	6	0
Part	III. 1903.	1	4	0	0	18	0
Part	IV. 1904.	0	6	0	0	4	6
Part	V. 1904.	0	6	0	0	4	6
Part	VI. 1904.	0	6	0	0	4	6
Part	VII. 1904.	0	6	0	0	4	6
Part	VIII. 1904. (In Progress.)	0	10	0	0	7	6
X. Part	I. 1904.	0	3	0	0	2	3
Part	II. 1904.	0	8	0	0	6	0
Part	III. 1905.	0	9	0	0	6	9

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With an Appendix by G. HERBERT FOWLER.

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By R. NORRIS WOLFENDEN, M.D., F.L.S., F.Z.S

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Part	II. 1875.	0	6	0	0	4	6
Part	III. 1876.	1	8	0	1	1	0
Part	IV. 1877.	0	16	0	0	12	0
Part	V. 1877.	0	18	0	0	13	6
Part	VI. 1877.	1	2	0	0	16	6
Part	VII. 1878.	1	16	0	1	7	0
Part	VIII. 1879.	1	0	0	0	15	0
II. Part	I. 1879.	1	4	0	0	18	0
Part	II. 1881.	0	15	0	0	11	6
Part	III. 1882.	1	8	0	1	1	0
Part	IV. 1882.	0	7	6	0	5	6
Part	V. 1882.	0	3	0	0	2	3
Part	VI. 1883.	1	0	0	0	15	0
Part	VII. 1883.	0	5	0	0	3	9
Part	VIII. 1883.	0	3	0	0	2	3
Part	IX. 1883.	0	3	0	0	2	3
Part	X. 1884.	0	4	6	0	3	6
Part	XI. 1884.	0	10	0	0	7	6
Part	XII. 1885.	0	6	0	0	4	6
Part	XIII. 1884.	0	6	0	0	4	6
Part	XIV. 1885.	0	6	0	0	4	6
Part	XV. 1885.	0	4	6	0	3	6
Part	XVI. 1885.	0	5	0	0	3	9
Part	XVII. 1886.	0	3	0	0	2	3
Part	XVIII. 1888.	0	2	6	0	2	0
III. Part	I. 1884.	1	14	0	1	5	6
Part	II. 1884.	1	12	0	1	4	0
Part	III. 1885.	1	10	0	1	2	6
Part	IV. 1885.	0	8	0	0	6	0
Part	V. 1887.	0	8	0	0	6	0
Part	VI. 1888.	0	6	0	0	4	6
IV. Part	I. 1886.	1	4	0	0	18	0
Part	II. 1887.	1	8	0	1	1	0
Part	III. 1888.	0	16	0	0	12	0
V. Part	I. 1888.	0	12	0	0	9	0
Part	II. 1888.	0	5	0	0	3	9
Part	III. 1889.	1	7	0	1	0	0
Part	IV. 1890.	0	12	0	0	9	0
Part	V. 1890.	0	6	0	0	4	6
Part	VI. 1891.	0	12	0	0	9	0
Part	VII. 1891.	0	6	0	0	4	6
Part	VIII. 1892.	0	8	0	0	6	0
Part	IX. 1892.	0	12	0	0	9	0
Part	X. 1893.	1	8	0	1	1	0
Part	XI. 1894.	0	2	6	0	2	0

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Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
VI. Part	I. 1894.	2	0	0	1	10	0
Part	II. 1894.	1	11	0	1	3	3
Part	III. 1894.	0	10	0	0	7	6
Part	IV. 1896.	1	4	0	0	18	0
Part	V. 1896.	0	10	0	0	7	6
Part	VI. 1896.	0	8	0	0	6	0
Part	VII. 1896.	0	12	0	0	9	0
Part	VIII. 1897.	0	2	6	0	2	0
VII. Part	I. 1896.	0	10	0	0	7	6
Part	II. 1897.	0	12	0	0	9	0
Part	III. 1897.	0	6	0	0	4	6
Part	IV. 1898.	0	10	0	0	7	6
Part	V. 1898.	0	18	0	0	13	6
Part	VI. 1898.	0	13	0	0	9	9
Part	VII. 1899.	0	18	0	0	13	6
Part	VIII. 1899.	0	12	0	0	9	0
Part	IX. 1899.	1	0	0	0	15	0
Part	X. 1900.	0	6	0	0	4	6
Part	XI. 1900.	0	2	9	0	2	0
VIII. Part	I. 1900.	0	10	0	0	7	6
Part	II. 1900.	0	10	0	0	7	6
Part	III. 1900.	0	10	0	0	7	6
Part	IV. 1901.	0	14	0	0	10	6
Part	V. 1901.	0	5	0	0	3	9
Part	VI. 1901.	0	10	0	0	7	6
Part	VII. 1901.	1	8	0	1	1	0
Part	VIII. 1902.	0	4	0	0	3	0
Part	IX. 1902.	0	5	0	0	3	9
Part	X. 1903.	1	0	0	0	15	0
Part	XI. 1903.	0	6	0	0	4	6
Part	XII. 1903.	0	10	0	0	7	6
Part	XIII. Index.	0	2	9	0	2	3
IX. Part	I. 1903.	0	9	0	0	6	9
Part	II. 1903.	0	8	0	0	6	0
Part	III. 1903.	1	4	0	0	18	0
Part	IV. 1904.	0	6	0	0	4	6
Part	V. 1904.	0	6	0	0	4	6
Part	VI. 1904.	0	6	0	0	4	6
Part	VII. 1904.	0	6	0	0	4	6
Part	VIII. 1904.	0	10	0	0	7	6
Part	IX. 1904. (In Progress.)	0	6	0	0	4	6
X. Part	I. 1904.	0	3	0	0	2	3
Part	II. 1904.	0	8	0	0	6	0
Part	III. 1905.	0	9	0	0	6	9
Part	IV. 1905.	0	10	0	0	7	6

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PART VII.—MOLLUSCA (excluding CEPHALOPODA).

BY

DR. PAUL PELSENEER, Professeur à l'École Normale de Gand.

With a Note on their Distribution, by G. HERBERT FOWLER, B.A., Ph.D., F.L.S., F.Z.S.

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II. Part I.	1879.	1	4	0	0	18	0
Part II.	1881.	0	15	0	0	11	6
Part III.	1882.	1	8	0	1	1	0
Part IV.	1882.	0	7	6	0	5	6
Part V.	1882.	0	3	0	0	2	3
Part VI.	1883.	1	0	0	0	15	0
Part VII.	1883.	0	5	0	0	3	9
Part VIII.	1883.	0	3	0	0	2	3
Part IX.	1883.	0	3	0	0	2	3
Part X.	1884.	0	4	6	0	3	6
Part XI.	1884.	0	10	0	0	7	6
Part XII.	1885.	0	6	0	0	4	6
Part XIII.	1884.	0	6	0	0	4	6
Part XIV.	1885.	0	6	0	0	4	6
Part XV.	1885.	0	4	6	0	3	6
Part XVI.	1885.	0	5	0	0	3	9
Part XVII.	1886.	0	3	0	0	2	3
Part XVIII.	1888.	0	2	6	0	2	0
III. Part I.	1884.	1	14	0	1	5	6
Part II.	1884.	1	12	0	1	4	0
Part III.	1885.	1	10	0	1	2	6
Part IV.	1885.	0	8	0	0	6	0
Part V.	1887.	0	8	0	0	6	0
Part VI.	1888.	0	6	0	0	4	6
IV. Part I.	1886.	1	4	0	0	18	0
Part II.	1887.	1	8	0	1	1	0
Part III.	1888.	0	16	0	0	12	0
V. Part I.	1888.	0	12	0	0	9	0
Part II.	1888.	0	5	0	0	3	9
Part III.	1889.	1	7	0	1	0	0
Part IV.	1890.	0	12	0	0	9	0
Part V.	1890.	0	6	0	0	4	6
Part VI.	1891.	0	12	0	0	9	0
Part VII.	1891.	0	6	0	0	4	6
Part VIII.	1892.	0	8	0	0	6	0
Part IX.	1892.	0	12	0	0	9	0
Part X.	1893.	1	8	0	1	1	0
Part XI.	1894.	0	2	6	0	2	0
VI. Part I.	1894.	2	0	0	1	10	0
Part II.	1894.	1	11	0	1	3	3
Part III.	1894.	0	10	0	0	7	6
Part IV.	1896.	1	4	0	0	18	0

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Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
VI. Part V.	1896.	0	10	0	0	7	6
Part VI.	1896.	0	8	0	0	6	0
Part VII.	1896.	0	12	0	0	9	0
Part VIII.	1897.	0	2	6	0	2	0
VII. Part I.	1896.	0	10	0	0	7	6
Part II.	1897.	0	12	0	0	9	0
Part III.	1897.	0	6	0	0	4	6
Part IV.	1898.	0	10	0	0	7	6
Part V.	1898.	0	18	0	0	13	6
Part VI.	1898.	0	13	0	0	9	9
Part VII.	1899.	0	18	0	0	13	6
Part VIII.	1899.	0	12	0	0	9	0
Part IX.	1899.	1	0	0	0	15	0
Part X.	1900.	0	6	0	0	4	6
Part XI.	1900.	0	2	9	0	2	0
VIII. Part I.	1900.	0	10	0	0	7	6
Part II.	1900.	0	10	0	0	7	6
Part III.	1900.	0	10	0	0	7	6
Part IV.	1901.	0	14	0	0	10	6
Part V.	1901.	0	5	0	0	3	9
Part VI.	1901.	0	10	0	0	7	6
Part VII.	1901.	1	8	0	1	1	0
Part VIII.	1902.	0	4	0	0	3	0
Part IX.	1902.	0	5	0	0	3	9
Part X.	1903.	1	0	0	0	15	0
Part XI.	1903.	0	6	0	0	4	6
Part XII.	1903.	0	10	0	0	7	6
Part XIII.	Index. ..	0	2	9	0	2	3
IX. Part I.	1903.	0	9	0	0	6	9
Part II.	1903.	0	8	0	0	6	0
Part III.	1903.	1	4	0	0	18	0
Part IV.	1904.	0	6	0	0	4	6
Part V.	1904.	0	6	0	0	4	6
Part VI.	1904.	0	6	0	0	4	6
Part VII.	1904.	0	6	0	0	4	6
Part VIII.	1904.	0	10	0	0	7	6
Part IX.	1904. .... (In Progress.)	0	6	0	0	4	6
X. Part I.	1904.	0	3	0	0	2	3
Part II.	1904.	0	8	0	0	6	0
Part III.	1905.	0	9	0	0	6	9
Part IV.	1905.	0	10	0	0	7	6
Part V.	1906.	0	7	6	0	5	3

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By Dr. W. E. HOYLE, Director of the Manchester Museum.
(*Communicated by* Dr. G. H. FOWLER, F.L.S.)

PART IX.—THE MEDUSÆ.

By E. T. BROWNE, B.A., Zoological Research Laboratory, Univ. Coll., Lond.
(*Communicated by* Dr. G. H. FOWLER, F.L.S.)

With a Note on the Distribution of the Medusæ by G. H. FOWLER, F.L.S.

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Volume.		When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Part I.	1879.	1	4	0	0	18	0
	Part II.	1881.	0	15	0	0	11	6
	Part III.	1882.	1	8	0	1	1	0
	Part IV.	1882.	0	7	6	0	5	6
	Part V.	1882.	0	3	0	0	2	3
	Part VI.	1883.	1	0	0	0	15	0
	Part VII.	1883.	0	5	0	0	3	9
	Part VIII.	1883.	0	3	0	0	2	3
	Part IX.	1883.	0	3	0	0	2	3
	Part X.	1884.	0	4	6	0	3	6
	Part XI.	1884.	0	10	0	0	7	6
	Part XII.	1885.	0	6	0	0	4	6
	Part XIII.	1884.	0	6	0	0	4	6
	Part XIV.	1885.	0	6	0	0	4	6
	Part XV.	1885.	0	4	6	0	3	6
	Part XVI.	1885.	0	5	0	0	3	9
	Part XVII.	1886.	0	3	0	0	2	3
	Part XVIII.	1888.	0	2	6	0	2	0
III.	Part I.	1884.	1	14	0	1	5	6
	Part II.	1884.	1	12	0	1	4	0
	Part III.	1885.	1	10	0	1	2	6
	Part IV.	1885.	0	8	0	0	6	0
	Part V.	1887.	0	8	0	0	6	0
	Part VI.	1888.	0	6	0	0	4	6
IV.	Part I.	1886.	1	4	0	0	18	0
	Part II.	1887.	1	8	0	1	1	0
	Part III.	1888.	0	16	0	0	12	0
V.	Part I.	1888.	0	12	0	0	9	0
	Part II.	1888.	0	5	0	0	3	9
	Part III.	1889.	1	7	0	1	0	0
	Part IV.	1890.	0	12	0	0	9	0
	Part V.	1890.	0	6	0	0	4	6
	Part VI.	1891.	0	12	0	0	9	0
	Part VII.	1891.	0	6	0	0	4	6
	Part VIII.	1892.	0	8	0	0	6	0
	Part IX.	1892.	0	12	0	0	9	0
	Part X.	1893.	1	8	0	1	1	0
	Part XI.	1894.	0	2	6	0	2	0
VI.	Part I.	1894.	2	0	0	1	10	0
	Part II.	1894.	1	11	0	1	3	3
	Part III.	1894.	0	10	0	0	7	6
	Part IV.	1896.	1	4	0	0	18	0
	Part V.	1896.	0	10	0	0	7	6

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.		When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
VI.	Part VI.	1896.	0	8	0	0	6	0
	Part VII.	1896.	0	12	0	0	9	0
	Part VIII.	1897.	0	2	6	0	2	0
VII.	Part I.	1896.	0	10	0	0	7	6
	Part II.	1897.	0	12	0	0	9	0
	Part III.	1897.	0	6	0	0	4	6
	Part IV.	1898.	0	10	0	0	7	6
	Part V.	1898.	0	18	0	0	13	6
	Part VI.	1898.	0	13	0	0	9	9
	Part VII.	1899.	0	18	0	0	13	6
	Part VIII.	1899.	0	12	0	0	9	0
	Part IX.	1899.	1	0	0	0	15	0
	Part X.	1900.	0	6	0	0	4	6
	Part XI.	1900.	0	2	9	0	2	0
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900.	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9
	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906. (In Progress.)	0	12	0	0	9	0
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	5	0	0	3	9

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

ZOOLOGICAL LIBRARY LIBRARY

BISCAYAN PLANKTON COLLECTED DURING A CRUISE OF H.M.S. 'RESEARCH,' 1900.

PART X.—THE FISHES.

BY

E. W. L. HOLT AND L. W. BYRNE.

(*Communicated by* Dr. G. H. FOWLER, F.L.S.)

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

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May 1907.

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SECOND SERIES.—ZOOLOGY.

Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
I.	Parts I.–VIII. 1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII. 1879–88.	7	17	0	5	18	5
III.	Part I. 1884.	1	14	0	1	5	6
	Part II. 1884.	1	12	0	1	4	0
	Part III. 1885.	1	10	0	1	2	6
	Part IV. 1885.	0	8	0	0	6	0
	Part V. 1887.	0	8	0	0	6	0
	Part VI. 1888.	0	6	0	0	4	6
IV.	Part I. 1886.	1	4	0	0	18	0
	Part II. 1887.	1	8	0	1	1	0
	Part III. 1888.	0	16	0	0	12	0
V.	Part I. 1888.	0	12	0	0	9	0
	Part II. 1888.	0	5	0	0	3	9
	Part III. 1889.	1	7	0	1	0	0
	Part IV. 1890.	0	12	0	0	9	0
	Part V. 1890.	0	6	0	0	4	6
	Part VI. 1891.	0	12	0	0	9	0
	Part VII. 1891.	0	6	0	0	4	6
	Part VIII. 1892.	0	8	0	0	6	0
	Part IX. 1892.	0	12	0	0	9	0
	Part X. 1893.	1	8	0	1	1	0
	Part XI. 1894.	0	2	6	0	2	0
VI.	Part I. 1894.	2	0	0	1	10	0
	Part II. 1894.	1	11	0	1	3	3
	Part III. 1894.	0	10	0	0	7	6
	Part IV. 1896.	1	4	0	0	18	0
	Part V. 1896.	0	10	0	0	7	6
	Part VI. 1896.	0	8	0	0	6	0
	Part VII. 1896.	0	12	0	0	9	0
	Part VIII. 1897.	0	2	6	0	2	0
VII.	Part I. 1896.	0	10	0	0	7	6
	Part II. 1897.	0	12	0	0	9	0
	Part III. 1897.	0	6	0	0	4	6
	Part IV. 1898.	0	10	0	0	7	6
	Part V. 1898.	0	18	0	0	13	6
	Part VI. 1898.	0	13	0	0	9	9
	Part VII. 1899.	0	18	0	0	13	6
	Part VIII. 1899.	0	12	0	0	9	0
	Part IX. 1899.	1	0	0	0	15	0
	Part X. 1900.	0	6	0	0	4	6
	Part XI. 1900.	0	2	9	0	2	0

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
VIII.	Part I. 1900.	0	10	0	0	7	6
	Part II. 1900.	0	10	0	0	7	6
	Part III. 1900.	0	10	0	0	7	6
	Part IV. 1901.	0	14	0	0	10	6
	Part V. 1901.	0	5	0	0	3	9
	Part VI. 1901.	0	10	0	0	7	6
	Part VII. 1901.	1	8	0	1	1	0
	Part VIII. 1902.	0	4	0	0	3	0
	Part IX. 1902.	0	5	0	0	3	9
	Part X. 1903.	1	0	0	0	15	0
	Part XI. 1903.	0	6	0	0	4	6
	Part XII. 1903.	0	10	0	0	7	6
	Part XIII. Index.	0	2	9	0	2	3
IX.	Part I. 1903.	0	9	0	0	6	9
	Part II. 1903.	0	8	0	0	6	0
	Part III. 1903.	1	4	0	0	18	0
	Part IV. 1904.	0	6	0	0	4	6
	Part V. 1904.	0	6	0	0	4	6
	Part VI. 1904.	0	6	0	0	4	6
	Part VII. 1904.	0	6	0	0	4	6
	Part VIII. 1904.	0	10	0	0	7	6
	Part IX. 1905.	0	6	0	0	4	6
	Part X. 1906.	0	12	0	0	9	0
	Part XI. 1907. (In Progress.)	0	12	0	0	9	0
X.	Part I. 1904.	0	3	0	0	2	3
	Part II. 1904.	0	8	0	0	6	0
	Part III. 1905.	0	9	0	0	6	9
	Part IV. 1905.	0	10	0	0	7	6
	Part V. 1906.	0	7	6	0	5	3
	Part VI. 1906.	0	3	0	0	2	3
	Part VII. 1907. (In Progress.)	0	3	0	0	2	3

2nd Ser. ZOOLOGY.] [VOL. X. PART 8.

THE

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PART XI.—DECAPODA.

BY

STANLEY W. KEMP, B.A.

(*Communicated, with a Note on their Distribution,* by G. H. FOWLER, B.A., Ph.D., F.L.S., F.Z.S.)

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October 1907.

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SECOND SERIES.—ZOOLOGY.

Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
I.	Parts I.–VIII. 1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII. 1879–88.	7	17	0	5	18	5
III.	Part I. 1884.	1	14	0	1	5	6
	Part II. 1884.	1	12	0	1	4	0
	Part III. 1885.	1	10	0	1	2	6
	Part IV. 1885.	0	8	0	0	6	0
	Part V. 1887.	0	8	0	0	6	0
	Part VI. 1888.	0	6	0	0	4	6
IV.	Part I. 1886.	1	4	0	0	18	0
	Part II. 1887.	1	8	0	1	1	0
	Part III. 1888.	0	16	0	0	12	0
V.	Part I. 1888.	0	12	0	0	9	0
	Part II. 1888.	0	5	0	0	3	9
	Part III. 1889.	1	7	0	1	0	0
	Part IV. 1890.	0	12	0	0	9	0
	Part V. 1890.	0	6	0	0	4	6
	Part VI. 1891.	0	12	0	0	9	0
	Part VII. 1891.	0	6	0	0	4	6
	Part VIII. 1892.	0	8	0	0	6	0
	Part IX. 1892.	0	12	0	0	9	0
	Part X. 1893.	1	8	0	1	1	0
	Part XI. 1894.	0	2	6	0	2	0
VI.	Part I. 1894.	2	0	0	1	10	0
	Part II. 1894.	1	11	0	1	3	3
	Part III. 1894.	0	10	0	0	7	6
	Part IV. 1896.	1	4	0	0	18	0
	Part V. 1896.	0	10	0	0	7	6
	Part VI. 1896.	0	8	0	0	6	0
	Part VII. 1896.	0	12	0	0	9	0
	Part VIII. 1897.	0	2	6	0	2	0
VII.	Part I. 1896.	0	10	0	0	7	6
	Part II. 1897.	0	12	0	0	9	0
	Part III. 1897.	0	6	0	0	4	6
	Part IV. 1898.	0	10	0	0	7	6
	Part V. 1898.	0	18	0	0	13	6
	Part VI. 1898.	0	13	0	0	9	9
	Part VII. 1899.	0	18	0	0	13	6
	Part VIII. 1899.	0	12	0	0	9	0
	Part IX. 1899.	1	0	0	0	15	0
	Part X. 1900.	0	6	0	0	4	6
	Part XI. 1900.	0	2	9	0	2	0

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
VIII.	Part I. 1900.	0	10	0	0	7	6
	Part II. 1900.	0	10	0	0	7	6
	Part III. 1900.	0	10	0	0	7	6
	Part IV. 1901.	0	14	0	0	10	6
	Part V. 1901.	0	5	0	0	3	9
	Part VI. 1901.	0	10	0	0	7	6
	Part VII. 1901.	1	8	0	1	1	0
	Part VIII. 1902.	0	4	0	0	3	0
	Part IX. 1902.	0	5	0	0	3	9
	Part X. 1903.	1	0	0	0	15	0
	Part XI. 1903.	0	6	0	0	4	6
	Part XII. 1903.	0	10	0	0	7	6
	Part XIII. Index.	0	2	9	0	2	3
IX.	Part I. 1903.	0	9	0	0	6	9
	Part II. 1903.	0	8	0	0	6	0
	Part III. 1903.	1	4	0	0	18	0
	Part IV. 1904.	0	6	0	0	4	6
	Part V. 1904.	0	6	0	0	4	6
	Part VI. 1904.	0	6	0	0	4	6
	Part VII. 1904.	0	6	0	0	4	6
	Part VIII. 1904.	0	10	0	0	7	6
	Part IX. 1905.	0	6	0	0	4	6
	Part X. 1906.	0	12	0	0	9	0
	Part XI. 1907.	0	12	0	0	9	0
	Part XII. 1907.	0	3	0	0	2	3
	Part XIII. 1907.	0	6	0	0	4	6
	Part XIV. In the press.						
X.	Part I. 1904.	0	3	0	0	2	3
	Part II. 1904.	0	8	0	0	6	0
	Part III. 1905.	0	9	0	0	6	9
	Part IV. 1905.	0	10	0	0	7	6
	Part V. 1906.	0	7	6	0	5	3
	Part VI. 1906.	0	3	0	0	2	3
	Part VII. 1907.	0	3	0	0	2	3
	Part VIII. 1907. (In Progress.)	0	4	0	0	3	0
XII.	Part I. 1907.	1	8	0	1	1	0

2nd Ser. ZOOLOGY.] [VOL. X. PART 9.

THE

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PART XII.—THE OSTRACODA.

BY

G. H. FOWLER, B.A., PH.D., F.L.S., F.Z.S.

LONDON:

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I. Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II. Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III. Parts I.–VI.	1884–88.	5	18	0	4	8	6
IV. Parts I.–III.	1886–88.	3	8	0	2	11	0
V. Parts I.–XI.	1888–94.	6	10	6	4	17	9
VI. Part I.	1894.	2	0	0	1	10	0
Part II.	1894.	1	11	0	1	3	3
Part III.	1894.	0	10	0	0	7	6
Part IV.	1896.	1	4	0	0	18	0
Part V.	1896.	0	10	0	0	7	6
Part VI.	1896.	0	8	0	0	6	0
Part VII.	1896.	0	12	0	0	9	0
Part VIII.	1897.	0	2	6	0	2	0
VII. Part I.	1896.	0	10	0	0	7	6
Part II.	1897.	0	12	0	0	9	0
Part III.	1897.	0	6	0	0	4	6
Part IV.	1898.	0	10	0	0	7	6
Part V.	1898.	0	18	0	0	13	6
Part VI.	1898.	0	13	0	0	9	9
Part VII.	1899.	0	18	0	0	13	6
Part VIII.	1899.	0	12	0	0	9	0
Part IX.	1899.	1	0	0	0	15	0
Part X.	1900.	0	6	0	0	4	6
Part XI.	1900.	0	2	9	0	2	0
VIII. Part I.	1900.	0	10	0	0	7	6
Part II.	1900.	0	10	0	0	7	6
Part III.	1900.	0	10	0	0	7	6
Part IV.	1901.	0	14	0	0	10	6
Part V.	1901.	0	5	0	0	3	9
Part VI.	1901.	0	10	0	0	7	6
Part VII.	1901.	1	8	0	1	1	0
Part VIII.	1902.	0	4	0	0	3	0
Part IX.	1902.	0	5	0	0	3	9
Part X.	1903.	1	0	0	0	15	0
Part XI.	1903.	0	6	0	0	4	6

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.	When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
VIII. Part XII.	1903.	0	10	0	0	7	6
Part XIII.	Index.	0	2	9	0	2	3
IX. Part I.	1903.	0	9	0	0	6	9
Part II.	1903.	0	8	0	0	6	0
Part III.	1903.	1	4	0	0	18	0
Part IV.	1904.	0	6	0	0	4	6
Part V.	1904.	0	6	0	0	4	6
Part VI.	1904.	0	6	0	0	4	6
Part VII.	1904.	0	6	0	0	4	6
Part VIII.	1904.	0	10	0	0	7	6
Part IX.	1905.	0	6	0	0	4	6
Part X.	1906.	0	12	0	0	9	0
Part XI.	1907.	0	12	0	0	9	0
Part XII.	1907.	0	3	0	0	2	3
Part XIII.	1907.	0	6	0	0	4	6
Part XIV.	1907. Index.	0	3	0	0	2	3
X. Part I.	1904.	0	3	0	0	2	3
Part II.	1904.	0	8	0	0	6	0
Part III.	1905.	0	9	0	0	6	9
Part IV.	1905.	0	10	0	0	7	6
Part V.	1906.	0	7	6	0	5	3
Part VI.	1906.	0	3	0	0	2	3
Part VII.	1907.	0	3	0	0	2	3
Part VIII.	1907.	0	4	0	0	3	0
Part IX.	1909. (In progress.)	1	1	0	0	15	9
XI. Part I.	1908.	0	4	0	0	3	0
Part II.	1909.	0	8	0	0	6	0
Part III.	1909.	0	6	0	0	4	6
Part IV.	1909.	0	12	0	0	9	0
Part V.	1909. (In progress.)	0	2	0	0	1	6
XII. Part I.	1907.	1	8	0	1	1	0
Part II.	1907.	1	4	0	0	18	0
Part III.	1908.	0	16	0	0	12	0
Part IV.	1909.	1	10	0	1	2	6
Part V.	1909. Index.	0	5	0	0	3	9
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Part XIII.—THE SIPHONOPHORA.

BY

HENRY B. BIGELOW, Museum of Comparative Zoology, Cambridge, Mass.

(*Communicated by* G. H. Fowler, B.A., Ph.D., F.L.S., F.Z.S.)

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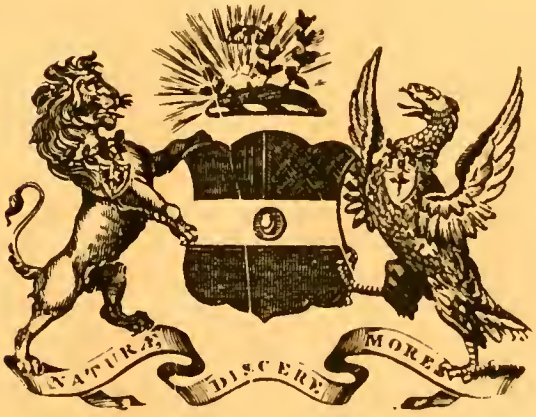

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Part II.	1910.	2	3	0	1	12	3
Part III.	1910.	0	16	0	0	12	0
Part IV.	1910. Index.	0	5	0	0	3	9
XIV. Part I.	1910.	1	18	0	1	8	6
Part II.	1911.	1	0	0	0	15	0
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Part II.	1913.	1	1	0	0	15	9
Part III.	1913.	0	12	0	0	9	0
Part IV.	1914.	1	10	0	1	2	6
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